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Automation Technology Applied to Public Service

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[2] Located at Boulder, Colorado 80302.

Automation Technology Applied to Public Service

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May 21-22, 1974

Edwin G. Johnsen, Editor

Institute for Computer Sciences and Technology
National Bureau of Standards
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PREFACE

Automation in countless forms has been developed and applied over many decades to increase the production of energy, commodities and goods, and has been a key factor in the development of modern nations. Automation has also caused profound changes in their social and economic environments, although these changes were generally welcomed because they improved the quality of life.

That automation technology has not yet been applied in a significant way to public service is revealed by the discussions summarized in these proceedings. However, potential uses are discussed by several participants who clearly delineate how automation technology can be beneficially applied to specific public service operations. Other participants authoritatively warn that the way in which automation technology is applied must be carefully thought out and supervised in order to minimize disruptive economic and social effects.

Some of the urgent needs for automation in public services discussed during the Conference include automating operations in environments hazardous to the safety and health of people, such as fire fighting. Other needs for automation include the automation of those services that are tedious, boring or demeaning for people to do. The spectrum of potential applications of automation technology in public service ranges from garbage collection to aids to the handicapped, and from water treatment process control to the adaptive computerized regulation of traffic in large urban areas.

Most of the Conference speakers illustrated their discussions with movies and projected pictures, charts and tables. With a few exceptions, these visuals are not included in this document because of the significant reproduction costs. In addition, several discussions have been reduced to a summary in this document, particularly where the actual discussion included frequent references to a series of slides or movies.

The Conference participants represented a variety of interests, and the professional occupations represented included managers, labor representatives, consumer advocates, industry representatives, technologists, and news reporters. Co-sponsored by the National Bureau of Standards, the General Accounting Office, the National Science Foundation and the Urban Institute, the participants had a common interest in the application of automation technology to the needs of public service. An appendix has therefore been included, as a part of the document, listing the attendees and their affiliations.

Edwin G. Johnsen
Conference Chairman
Institute for Computer Sciences and Technology
National Bureau of Standards

Gaithersburg, Maryland
December 1974

ABSTRACT

The Conference on Automation Technology Applied to Public Service, held in May 1974, was co-sponsored by the National Bureau of Standards, the General Accounting Office, the National Science Foundation and the Urban Institute. The objectives of the conference were first, to explore the use of automation technology as a means of increasing the efficiency of Government in providing higher quality public services at lower cost; and second, to explore the political, social and economic aspects involved in managing the public service applications of automation. Potential uses of automation technology discussed include automating operations in environments hazardous to safety and health of people, such as fire fighting, and the automation of services that are tedious, boring or demeaning for people to do. The spectrum of potential applications of automation technology in public service ranges from garbage collection to aids to the handicapped and from water treatment process control to the adaptive computerized regulation of traffic in urban areas. Some participants warn that the way in which automation technology is applied must be carefully thought out and supervised in order to minimize disruptive economic and social effects.

KEY WORDS: Automation technology; economic impact of automation; productivity improvement; public services; social impact of automation.

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Joseph Carlson, Public Technology, Inc.

David R. Brown, Stanford Research Institute

William Bradley, Automation Consultant

Norman Caplan, National Science Foundation

Robert Zimmerman, National Aeronautics and Space Administration

EXECUTIVE SUMMARY

Automation Technology Applied to Public Services, a conference held at the National Bureau of Standards in May 1974, drew together a diverse group of people, representing many points of view and disciplines, to discuss technological advances in automation technology and possible applications by government to improve public services. Automation, the use of machines and devices to assist, as well as replace, human control functions, offers the potential of increasing productivity and improving the quality of goods and services. However, the human implications - the spectre of unemployment and dehumanization - must be considered and dealt with if automation is to serve man effectively.

Jointly sponsored by the General Accounting Office, the National Science Foundation, the Urban Institute and the National Bureau of Standards' Institute for Computer Sciences and Technology, the conference was organized in seven sessions to deal with the multiplicity of issues.

In her Introductory Address, Dr. Ruth M. Davis, Director of the Institute for Computer Sciences and Technology, identified the motivations for applying automation to public services as:

- providing services in environments that are hazardous or harmful to people,
- providing services that demand faster operations than can be performed by people,
- satisfying the increasing public demand for accountability in the provision of public services and for protection of individual rights, such as privacy,
- providing services that are tedious, boring or demeaning for people to do and are therefore performed poorly by people,
- improving the quality of services.

The term "automation" was coined in the 1940's to describe a production process in which a transfer machine moves parts between various steps in a production line and has been expanded in scope to mean the presence of machines or devices in the control system of a process. Agriculture, manufacturing, paper handling and recordkeeping have been automated with different levels of worker participation and planning for social change. The conflicts attendant to automation in the grocery industry indicate the importance of including the consumer in planning for changes.

> "The objective of this Conference is to provide you with a sampling of the best of understanding, of concerns, of problems, of advantages and of the realities of automation applied to public service," Dr. Davis stated.

The Keynote Address by Thomas D. Morris, Assistant Comptroller General of the United States, focused on Federal government efforts to enhance productivity. There has been a significant increase in the past few years in the number of persons in the labor force employed in service sector employment as opposed to the goods-producing sector. Studies indicate that increases in productivity in the Federal government can be measured and that innovation and carefully planned change are responsible for the improvements.

> "While public resources are squeezed between public demands for services and the rising costs of meeting those needs, there is growing resistance on the part of the public to providing more resources through higher taxes. One answer to this dilemma is improved productivity. The secret of doing more with the same resources is the substitution of capital for labor, in the form of mechanization, automation, and computerization."

ECONOMIC AND SOCIAL VIEWS OF AUTOMATION

Mr. Markley Roberts, Economist with the American Federation of Labor-Congress of Industrial Workers, said that the threat of unemployment has sparked labor interest in the possible destructive effects of technological changes on workers and their jobs. Despite the promise of better goods and services, more satisfying work and higher pay, automation can have a devastating effect on workers who lose jobs with minority, less educated and less skilled workers hit hardest. Emphasis was placed on worker participation through collective bargaining to negotiate and plan for protection during technological change, and the absence of this process in the public sector was noted.

Mr. Louis H. Blair, Senior Research Staff of the Urban Institute, cited the difficulties of adopting technology to make cities better places in which to live because of the resistance to change and the inapplicability of much technology to the cities.

"The benefits of proposed technology applications have not been well specified, nor have the implementation processes been clearly defined. Rarely, if ever, do the proposed projects or solutions consider the impacts on society. . . . technology must be used as a means for improving the condition of cities and humanity, and to provide a chance and an opportunity for us to manage technology to improve humanities, and to make technology, humanity and cities compatible."

SESSION I. Automation for Urban Public Service Operations

Chairman, Joseph M. Carlson, Assistant to the Senior Vice President, Public Technology, Inc., observed that local government officials need to evaluate costs and benefits that new technological developments offer.

"They must also be innovative and in many areas must take the lead, in developing new approaches to their problems, and in developing new applications in local government for technology. . ."

The automated operation of the water service for the metropolitan Philadelphia area was described by Carmen F. Guarino, Commissioner and Chief of the Water Department. The quality of the water, flow and pressure in the piping system and chlorine content of water is monitored by satellite scanning. Rapid communication and data handling are facilitated by automation which is also applied to the control of wastewater treatment operations. The completely automatic control of water plants is dependent upon the development of sensors capable of withstanding the harsh wastewater environment.

The search for automatic equipment to fight fires has been motivated by the rising costs of fire services according to Warren E. Isman, Captain, Fire/Rescue Services, Montgomery County, Md. Automation applications controlling traffic signals on route to fire scenes, remote control of large stream nozzles and automatic pumpers have improved safety for firefighters. Retrieval of pre-fire planning information which could be collected when firefighters inspect buildings is a possible area for future automation.

Marc G. Stragier, Deputy City Manager of Scottsdale, Arizona discussed the use of mechanized equipment to collect refuse. Refuse collection is an expensive service to provide to citizens and a hazardous occupation for the workers employed.

"Refuse collection is entering a new era of development. Emerging from the old methods of can-truck-dump are the new systems of mechanized collection with their accompanying advances of increased safety, savings and sanitation. The mechanized system he uses is less costly, more sanitary, safer, more productive and popular than conventional collection. The work being done by various cities supports these conclusions."

Donald S. Wasserman, American Federation of State, County and Municipal Employees, emphasized the importance of including workers performing day-to-day routine jobs in the planning to solve the problems associated with their jobs.

"Public service employees, and unions that represent the employees, generally welcome automation. Automation can be viewed in two ways. As workers, automation can be viewed as a means for removing some of drudgery from some of the common place employment in public service. Public service employees must also view automation as consumers and taxpayers."

James McManama, Director of the Data Processing Center of the City of Dayton, Ohio, spoke of the requirement of city officials for information easily derived from information collected by the city for other purposes. However, historically data processing centers have been designed, developed and installed in a decentralized manner.

"We need systems to automate the fire department, and our service department, which includes building inspection." "Until recent times there was no opportunity or need for automation technology to correlate people-oriented data, to identify just what functions are being performed vis-a-vis what should be done, the costs of those functions which cross the classic organizational lines, etc. There is now."

SESSION II. Automation for Occupational Welfare

Chairman John H. Stender, Assistant Secretary of Labor cited the benefits of automation in reducing the total number of people needed to grow food and eliminating hazards of some manufacturing jobs such as punch press operations and chemical processing. The potential use of automation for ocean-bottom mining, energy reclamation, space exploration, mineral excavation on the moon and other planets and deep earth mining needs to be developed.

> "Automation in and of itself is neither good or bad. It's what we make of it that counts. The worst thing we could do now would be to do nothing -- to ignore its potential, to not plan for its use or introduction."

Dr. Roswell L. Atwood, Director of Education, International Association of Fire Fighters, suggested the need for fire detection sensors in high rise buildings, designation of places in buildings where people might go safely in case of fire and control systems for smoke and fire in order to improve the safety of fire fighting. Fire fighters entering homes filled with fumes from burning plastics could be better protected if they had devices to analyze the fumes and to detect the presence of human beings in the smoke filled environment.

> ". . . no major effort is being undertaken for the application of technology to fire fighting. It would seem that today's technology would be able to provide innovative devices which would augment the necessary physical exertion of firefighters."

William Bradley, an automation consultant, discussed the expense and danger of deep sea operations such as installation of equipment for oil operations, deep sea salvage, mining on the ocean floor, and pointed out the advantages of "telefactor" systems - remotely operated systems with man in a safe environment operating the machine as well as if he were located in it. The development of these devices will

> ". . . start a new industry which will have the interesting characteristic of not displacing existing industry, but of allowing economic expansion into activities now too hazardous, expensive or unhealthy to be performed other ways. Both Labor and Management have good reasons to endorse such an industry, and urgency of off-shore petroleum production now provides a timely incentive."

Wayne R. Knowles, Division of Waste Management and Transportation, Atomic Energy Commission, described two projects being developed to improve occupational health and safety in the handling of radioactive waste. In the handling of certain low-level radioactive waste, combustible and non-combustible materials must be separated for further processing. Separation is done by a man reaching into a box through rubber gloves sealed to the box.

A second system is designed to remotely handle the opening of canisters containing high-level radioactive waste from a shielded cell and viewed through shielded windows or on TV monitors. While both procedures take precautions to protect men from the waste, if operations could be performed by automated equipment, men could be removed from hazardous environments and occupational health and safety could be improved.

The perspective of the worker faced with loss of job due to automation was the concern of Ron J. Straw, Director of Development and Research, Communications Workers of America. Union bargaining centers on protection of the individual, his income and his pursuit of happiness, and the Government can play a role in easing the transition to the use of automated equipment by shouldering the cost of preserving the worker.

> "The emphasis on automation must be placed on accommodating the needs of people and not as much on efficiency."

SESSION III. Automation for the Handicapped

This session was chaired by J. Malvern Benjamin, Jr.,President Bionic Instruments, Inc.

> ". . . any planning that we do involving technology should include all of the people that are going to be directly affected. Technology should not be considered as a separate activity but as a part of a total system."

Dr. Kenneth R. Ingham, President, American Systems, Inc. described a system to aid the blind using a standard time-sharing system on a mini-computer. Instead of a visual readout on a CRT or teletype, the readout is performed by a voice response unit with a two to three thousand word vocabulary. The device enables a blind person to write down information in the formats that the sighted world requires. Books, texts and records can be made available to the blind through the use of reading machines.

"The intent is to find simple, easy to learn techniques that can enhance the employment potential of the blind."

Dr. Eugene Kwatny, Kursen Center for Research and Engineering, Temple University School of Medicine, described research on devices equipped with sensors for feedback aids for people with sensorimotor disabilities. A limb load monitor provides information spacially and temporally of applied vertical load of the lower limb.

"The distribution of devices . . . has been slow and inadequate because of the lack of funds to move a device from the research laboratory to the consumer and the lack of interest of manufacturing companies because of the small profit margin in producing limited quantity items."

A Veterams Administration program to provide therapeutic and rehabilitative devices was presented by Wilfred B. Holsberg. In addition to providing traditional prosthetic and sensory aid devices, work is being done on minaturized electronics to control a remote manipulator to be mounted on a wheel chair and controlled by a quadriplegic using a combination of head motions, EMG signals, voice control or breath control.

Dr. James S. Albus, scientist at the National Bureau of Standards, suggested several applications of automation technology to reduce the costs and improve the availability of medical tests, decrease the cost of medical educations for doctors and to improve the mobility of the crippled and aged to reduce the need for nursing care. Devices to make the handicapped more independent pose problems of manipulator control because of the many degrees of freedom required to simulate arm and hand motions. NBS is exploring an associative memory approach to programming motions in a manipulator. A memory driven control system incorporating many different kinds of touch and force feedback in the motion computation offers the possibility of easily controlled motions for a handicapped person.

SESSION IV. Recovery of Ocean Resources for Public Benefit

Co-chairmen of session were Dr. Athelstan Spilhaus, Special Assistant to the Administrator, NOAA and Dr. Milton G. Johnson, Office of the NOAA Corps.

The use of modeling as an aid in predicting the condition of rivers was described by Dr. Anthony Mucciardi, Adaptronics, Inc. The use of environmental variables - river flow rate, river staging, the tide level, precipitation and average daily temperature as input variable - allowed the establishment of four models. The success of these techniques was demonstrated by the accuracy of the models in predicting the actual count of the bacteriophage of the river.

Earl J. Beck described equipment developed in the Naval Civil Engineering Laboratory, Port Hueneme, California - a Seafloor Constructor, a milling machine that will cut an excavation to a prepared pattern, and a Deep Sea Corer, a complex machine designed to work on the ocean botton. Restricted visibility in the deep ocean poses problems in positioning equipment. Sound signals can be used, but experience has shown that numerical control or computer control could facilitate operation of ocean equipment.

Work done by the Naval Undersea Center was detailed by Richard W. Uhrich. Advances in equipment include a teleoperator system with linkage construction of the arm to allow the manipulator to operate in a spherical coordinate system. Another innovative piece of equipment is a submersible vehicle, Snoopy, weighing 100 pounds, capable of operating to a depth of 100 feet and equipped with TV and movie camera, small hook and reel to recover objects from the ocean floor.

"The deep ocean is an extremely hostile environment where it is neither safe nor cost effective to place man on the scene. Instead, remotely controlled vehicles and equipment, as well as automated systems have and will play a great role in exploration and in performing useful work on the ocean floor."

The National Oceanic and Atmospheric Administration project to collect oceanographic data while monitoring pollution levels on the continental shelf and in lakes and rivers was outlined by Gary Guenther of the Engineering Development Laboratory, NOAA. The "Sea Scan" system continuously samples water while a ship is underway. The data collected facilitates accurate modeling of the macrostructure of ocean dynamics and determination of baseline pollution levels. With mini-computer controlled instrumentation and the availability of near real-time, processed data in a visual format, scientists will be able to interact with the data and tailor acquisition of data to track moving and changing phenomena in the ocean.

The use of data buoys as automated environmental monitoring and reporting devices by the National Weather Service to provide environmental data to meet a wide variety of needs related to weather analyses and prediction, monitoring of the environment and scientific research was addressed by LCDR Robert H. Cassis, Jr., USCG, NOAA Data Buoy Office, Mississippi Test Facility.

"The data buoy can be designed to operate effectively in severe environments and is essentially an all-weather device. Since it is unmanned, expensive life support systems are not required and personnel are not subjected to the sometimes tedious and arduous life on board data acquisition vessels. Buoy support work is technically challenging, highly productive and generally desirable. Thus the data buoy as an automated system permits the acquisition of data which is important to the understanding and evaluation of the marine environment's usefulness to man while at the same time providing a meaningful experience for the system support personnel."

SESSION V. Recovery of Underground Resources for Public Benefit

Chairman, William B. Schmidt, Chief, Division of Mining Research-Resources, U.S. Bureau of Mines, pointed out the importance of coal reserves as an energy source because of the near future depletion of other sources such as oil and gas. Automation appears to be applicable to the most widely used method of underground mining of coal--the continuous mining method that combines the functions of undercutting, drilling, blasting, and loading in one machine.

". . . historical productivity increase has been achieved by increased mechanization. . . . It appears that there is ample justification for pursuing a R&D program to improve mining technology if we are to assure energy to meet our needs."

Wilbur C. Helt, Director, Engineering & Statistical Services, National Coal Association, suggested increasing coal production was feasible. The cooperation of labor, the infusion of young miners into the industry, increased profitability for investors, changes in the Clean Air Act to permit the burning of high sulfur coal and research and development in both the production and uses of coal can contribute to increased viability of the coal industry.

"A national policy will assure the uses of coal in the tasks it is best fitted to perform, and conserve our scarcer fuels for specialized uses. It will assure coal's long-term future markets so our industry can finally plan for and attract the huge amount of capital essential to its necessary expansion."

Congressman Barry M. Goldwater, Jr. expressed the interest of his House Science and Astronautics Committee (now the Science and Technology Committee) in new approaches to solving energy problems with public and private sectors of society and the economy working together.

"The coordination and integration of many disciplines holds the key to successfully automating the recovery of underground resources."

SESSION VI. Impact of Automation on the Public

Chairman Wil Lepkowski, Science and Technology Editor of the Washington New Bureau of McGraw-Hill World News, set the theme of the session -- man's control over machines rather than his domination by them.

"The fundamental question is to ask how automation can help man become whole and maintain that sense of wholeness. Government's role isn't necessarily to make man whole, but to create the conditions conducive, in America's case, to the working out of the democratic process."

The science fiction perspective of technology, according to Ben Bova, Editor of Analog Magazine, is that of a dynamic, anti-conservative force, that liberates people. Just as the steam engine destroyed slavery, technology will liberate people from drudgery and boring jobs.

John McCarthy, Director, Artificial Intelligence Laboratory, Stanford University, envisaged the use of technology to greatly expand man's access to printed information. A national information system could be built of many interconnected sub-information systems in which everything that is published or has been published can be stored. Anything could be published and people would decide what they want to read.

Society's barriers to the infusion of robots to do work was discussed by Dr. James A. Albus, Project Manager, Office of Developmental Automation and Control Technology, NBS.

> ". . . if robots can do the work, then how do people get the income? . . . if the robots can operate industries by themselves, that represents an enormous concentration of economic power. Who owns that power and who controls it?"

Dr. Daniel V. DeSimone, Deputy Director, Office of Technology Assessment, U.S. Congress, commented on the swing away from thinking about technology as being wholly beneficial to man to a feeling that it is a threat to our mental and emotional balance.

> "OTA gives Congress a new window with a fresh outlook on technological issues that are increasingly important in national decision making. . . . technology assessments will deal with some of the most urgent and troublesome problems of our times, . . . preservation of our environment, ecology, wise use of natural resources, human health and safety, assurance of ample food, and long-term social and economic effects on large groups of people, such as the urban poor and small farmers."

Louis K. O'Leary, Assistant Vice President, American Telephone and Telegraph, described the importance of automation to the operation of the national telephone system with its resulting better service for people. Based on his experience in telephone system,

> "Automation must be managed. Technology must be introduced ready-cut to the human measure."

The development of technology over time, according to Dr. Michael MacCoby, Director, Harvard Project on Technology, Work and Character, has reflected the needs of institutions. Technology developed by government has been for security and that by private markets for corporate growth and profit, rather than for the humane development of individuals. Our current principles are leading in the direction of producing two classes, one of technocrats who will live in enclaves protected from the second class who are expected to be passive consumers, with drugs and violence as their only excitement.

Gus Tyler, Assistant President, International Ladies Garment Workers Union, spoke of the social changes brought about by automation. The post-World War II expanded buying power, shorter work weeks, greater use of credit buying, increased pension and welfare funds and government spending have been accompanied by expansion in the service economy and in the number of people employed in skilled and professional positions. Fewer people are employed in making things for others to consume. More women are employed because of the changing nature of work and automation in the home. Automation in farming has had a tremendous impact on urban life because of the migration of people from farms to cities that were ill-prepared to accommodate them with decent jobs, housing and education.

SESSION VIII. Automation for Transportation

Dr. Robert H. Cannon, Jr., Assistant Secretary of Transportation, chairman, discussed improved safety resulting from automation of air traffic systems. R&D programs in DoT have focused on the use of automation to improve existing systems of transportation rather than advocating other systems which require large amounts of capital to fund. Automated control of traffic lights has proved effective in increasing traffic flow and decreasing trip time. The extension of automation to rapid transit systems, control and management of bus systems and freight car identification and management has promise for real payoffs with little investment of capital.

Dr. Carl R. Peterson, President, Rapidex, Inc., spoke of the application of automation in underground excavation of rock in conventional drill and blast techniques.

> "Experiments using a relatively conventional basic tunnelling method with conventional equipment components indicate that with automation or remote control, an increase of 300% in productivity might be possible. This represents an opportunity where automation could be immediately helpful, rather than at some future date."

The use of the computer to improve services in dial-a-ride systems was predicted by Jerry D. Warn, Director, Office of R&D Policy, U.S. Department of Transportation. Riders may be able to use a telephone to inform the computer of their locations and destinations and be provided with the time of pick-up and cost of ride.

". . . the quality of the vehicular service will gradually improve, and at some point a dramatic improvement will be made in the information system. These improvements will, in turn, increase the ridership, thus decreasing the cost per passenger mile."

Daniel Roos, Associate Professor, Department of Civil Engineering, Massachusetts Institute of Technology, traced the historical development of dial-a-ride systems. They have proved successful in getting people to destinations in low density areas where fixed route service is not economical and to bring people to train and bus stations. Computers are beginning to be used to help in dispatching vehicles through digital communications systems and through processing of requests.

Automated traffic control, described by Donald L. Cooper, Manager, Houston Office, Transportation Controls, TRW, Inc., is directed toward moving the maximum number of cars through a network with the minimum number of stops.

"The benefits obtained from these systems are difficult to quantify. Baselines from which to measure benefits are hard to define. Known benefits include energy conservation, decreased pollution, safety, and savings in user time. Several studies indicate a 20% decrease in travel delay time. By assigning conservative values to these benefits, estimated savings of $1 million/year are not unreasonable."

This conference identified opportunities for application of automation in urban services, occupational welfare, aids to the handicapped, recovery of ocean and underground resources, and transportation. The consensus of the participants was that while there are many compelling reasons for applying automation in public services, automation must be managed and the rate of applications must be paced in order to cope with job dislocations.

AUTOMATION TECHNOLOGY APPLIED TO PUBLIC SERVICE

INTRODUCTORY ADDRESS

by
Dr. Ruth M. Davis
Director
Institute for Computer Sciences and Technology
National Bureau of Standards

Automation technology and, particularly, automation technology applied to public service, appears to be a very timely subject for this Conference. Our most careful historical checks show that this could indeed be the FIRST Conference devoted to automation technology applied to public service. If true, this is indeed a landmark Conference. Even allowing for some historical recording errors, this Conference is very obviously addressing an uncommon theme.

The resultant observation that automation and public services have been strange bedfellows is revealing. It could mean that automation technology is of such recent origin that its potential for improving public services has not yet been identified. Or, it could mean that public services are either not in need of an infusion of any of the technologies of automation or are now being handled to the satisfaction of the public. I would surmise that neither of these hypotheses is correct.

Instead, I would suggest that we have let ourselves be blinded by ugly examples of the mishandling of automation in the recent past to the extent that we find it almost impossible to view its successes and potential. And, indeed, ugly examples are numerous. Perhaps, though, they reflect more on our inadequacies as managers, as technologists, as workers, and as consumers to handle technology than they do on automation technology.

The Neutrality of Technology

For technology is neutral. Society can make what it wishes out of technology. Technology does not come with a label specifying its end-use. Surprisingly, the user and the public have the same rights and prerogatives in determining the end-uses of technology as its developers -- in fact, they have a more lasting influence.

In actuality, a technology-rich society is a very lucky society. The creative combination of technologies often yields unexpectedly useful products and services. Flemming and Becquerel had no inklings of penicillin or radioactive tracers when they set to work. Safer air travel was not the motivation for developing computer-controlled cathode ray tubes. But fortunately, it was one of the results.

With participatory democracy and the communications modalities available today, there is no excuse for society not exerting its influence to make automation technology its own servant for its own good. Concomitantly, there is no escape for a society wanting to leave technology to technologists. The latter scenario is now a historical figment of our imagination. Technology and decisions about its use as well as conscious decisions not to use it are public responsibilities.

Applications of Automation Technology to Services

There are compelling motivations for automation in services that transcend the desires of individuals or special interest groups. Some of these basic motivations are:

- Providing services in environments that are hazardous to people or harmful to their safety.
- Providing services that demand faster operations than can be performed by people.
- Satisfying the increasing public demand for accountability in the provision of public services and for protection of individual rights, such as privacy.
- Providing services that are tedious, boring or demeaning for people to do and are therefore performed poorly by people.
- Improvement in the quality of services.

Although there are powerful driving forces for applying automation to services, there are only a few instances of widespread automation in the service sector today. Computers, computer systems, computer networks and mechanized paper handling are the principal manifestations of service sector automation. Also, sensors in automated systems are becoming increasingly common and substitute well for the human senses of hearing, sight, smell, touch and taste.

Applications Highlighted by the Conference

A look at the program for this Conference cannot help but highlight, for us all, the as yet almost unexplored treasure-trove of applications which automation technology holds for us as individuals and as a nation. The mechanized trash collection system experimented with in Scottsdale, Arizona lends dignity to the occupation of trash collection, offers improved productivity and promises a better quality of public service to the Scottsdale resident.

Building protection and prison surveillance can be made safer occupations for guards with a simultaneously more uniformly dignified treatment of building residents and prisoners. The handicapped can be provided automated aids so as to humanize their lives and provide them considerably broader occupational opportunities. Whether these aids are laser canes, automated braille typewriters or touch-tone keyboards for remote computer usage, they are manifestations of automation humanizing individuals and performing a public service.

Fire-fighting may be unnecessarily dangerous when firemen can remotely fight fires via remotely-controlled equipment and yet-to-be-designed visual aids that can penetrate smoke-filled rooms. Underground mining can be considerably more automated than presently is the case. Human miners and canaries should not be subjected to black lung disease and methane atmospheres in unsafe and unhealthy mines. Remotely-controlled mining equipment operates equally well in methane or earth atmospheres. Miners can enjoyably and comfortably control such equipment from above-ground control sites. And, although mining may not be a public service, occupational health and safety is.

Automation in transportation is not a new phenomenon. Air traffic control, the BART system of San Francisco and automated identification of railroad cars have become highly visible to the public both because of their innovativeness and their problems. The problems will disappear as the management and the substance of the technology improves. But, the human ingenuity behind these applications and their utility to the public will long outlast the problems.

The Spectrum of Automation Technology

As can be seen by the above examples, automation is not a simple technology. Automation is a term coined in the 1940's to describe a production process: in particular, it referred to the mechanized process in which a transfer machine moves parts between various steps in a production line. Never clearly defined, the term, automation, has in recent years expanded in scope to include the use of machines and devices to assist, as well as to replace, human control functions.

Automation today always assumes the presence of machines or other devices in the control system of a process. Mechanical, hydraulic, electrical, electronic, optical and computer systems illustrate the range in types of automation in control functions. If there is a single concept integral to automation, it is the presence of machines or other devices in the control system of a process.

The spectrum of automation can be depicted as a series of levels of increasing technological sophistication. In some ways, technological sophistication is inversely related to the degree of human involvement. Mechanization generally requires far more human involvement than does soft automation and "total" automation virtually eliminates man from the control function.

"Mechanization" is automation with mechanical control systems and by convention is usually treated separately from automation. Indeed, "mechanization" contained the process for which the term automation was initially coined.

Those instances in which the control function is fixed or not easily changeable during the automated process are referred to as "hard" automation.

In addition to mechanization, soft automation (programmable automation) and hard automation (fixed control devices), still another manifestation of automation has gained popularity. This latter type of automation is known by the label "teleoperator" or "telefactor." Teleoperators are machines which permit man to project his manipulatory, mobility and visual capabilities remotely. Control is always exercised by a person through communications which couple him with his remotely located extended capabilities, i.e., teleoperators.

A comforting feature of automation is that it is not synonomous with the elimination of people. People in a control function are generally assisted by machines. They may, of course, also be eliminated -- but that is only one option.

Historical Perspective of Automation

Is there more to automation technology than its introduction and application -- hopefully for public benefit? There are, of course, many other facets to any application of technology. The perspective provided to us by history is one of mixed blessing.

Agriculture

Mechanization, a form of automation, has saturated the agriculture industry and grossly changed its methods of production. Mechanization in agriculture dramatically improved productivity and reduced the percentage of the national labor force engaged in farming from over 50% in the 1950's to 4.5% in 1970.

There was virtually no government involvement in the mechanization of agriculture. The lack of institutional planning for mechanization by government, labor or management is cited by many as being the cause of deleterious social effects resulting from the mechanization of agriculture. These included too rapid urbanization, glutting of the industrial work force by unskilled farm laborers and an excess of agricultural products which had to be held down by later governmental initiated mechanisms such as subsidies for untilled land and government-initiated foreign sales.

Manufacturing

Automation is widespread in manufacturing but has not yet saturated it as is the case with agriculture. One reason for this difference is the institutional mechanisms employed by unionized labor to control and to pace the spread of automation in manufacturing.

Automation in manufacturing, until recently, took the form of assembly machines, production or assembly-line machines, transfer machines and N/C tools. These forms of automation (principally mechanization) found their primary market in large volume, fixed, repetitive production processes.

Since the mid-1950's, industrial robots have been finding a steadily increasing set of uses in manufacturing. There are some 1500-2000 industrial robots employed worldwide with about half being in the United States. The principal applications of industrial robots have been in handling hot or heavy objects.

As industrial robots have been finding increasing utility, they have also caused increased disatisfaction in labor. It is no accident that the workers in the Lordstown plant utilizing industrial robots in the production at the Vega sabotaged parts on the production line. There is no evidence that the workers had been involved in the planning for that particular automated system. In this case, the fault was not with automation but was the direct result of how the innovation process was introduced.

Industrial robots appear to be the transition technology from mechanization in manufacturing to computer-aided design and computer-aided-manufacturing (CAD/CAM) which are still in primitive development stages. Computer-aided-design (CAD) has as a primary objective a dramatic speed-up in the elapsed time between initial product concept and production operation. Computer-aided-manufacturing (CAM) has a primary objective, computer control of manufacturing including scheduling, resource control and control of actual production processes. CAD/CAM considered together offer high potential for improving product quality and reliability, for reducing product costs, for dramatically accelerating the design process and thus decreasing R&D costs for new products, and for changing manufacturing process technology so as to benefit both our national security interests and our economy.

Paper-Handling and Record-Keeping

Paper-handling and record-keeping have always been essential to public demands for accountability. This demand for public accountability is dramatically increasing, and is unavoidably accompanied by increased need for paper-handling and record-keeping.

There are few occupations disliked more and performed worse by people than paper-handling and record-keeping. These jobs epitomize the tedious, boring and repetitive daily chores which people point to as examples of dehumanization and symbols of discontent with the now much-beleagued "work-ethic."

Here again, the greatest changes in methods of paper-handling and record-keeping have involved mechanization and automation, particularly via the computer route to automation.

The View of the Worker, the Consumer and the Public

In addition to the historical perspective of automation, there is the close-at-hand view of the worker, the consumer and the public. We read and we sense that, as workers, we are becoming slaves to machines rather than vice versa. There is an association between this discontent and the sense of a lack of individuality, and the poor self image of being only a part of a lower echelon of machines that is associated with automation technology. That association is a wrong one, but it will take many years to replace with a proper perspective of automation and a proper introduction of automation to enhance rather than decrease the sense of human individuality.

Automation in the Grocery Industry

Automation has had many pitfalls in its course of introduction. For example, the grocery industry is planning on automating the grocery check-out counter. The automation will allow faster price changes,

a more detailed and readable check-out slip for the shopper, less price miscalculations by the checker and faster check-out times. But, in order to afford the costs of the automation, prices are going to be removed from the shelf. Consumers and consumer representatives do not approve of this latter change -- that of removing prices from shelf items. A consumer group in Massachusetts has agreed to boycott the first supermarket chain introducing the automated check-out counter.

It seems too late for the grocery shopper, in this case, to affect the changes being made by automation other than by becoming an outspoken adversary to them. The consumer was not included in the planning for grocery store automation. If he had been involved in planning its introduction, perhaps a compromise might have been reached -- one that would have reaped many of the benefits of automation and still been in the interests of the consumer. The alternative is an adversary relationship that is detrimental to everyone and is very damaging to the useful and humane use of automation technology.

Technology, People and Compromise

Writers speak of run-away technology and of the scars of being just a machine on the job all day. They speak of the automated pace of our daily lives and they cite a number of examples that already exist. These examples include automation in health care, in education, in garbage collection, warehouse, and car diagnosis.

Technology seems to be always present in the problem scenario, sometimes as an adversary, sometimes as a friend and sometimes as a misunderstood factor. It is no wonder that there is a real urgency to effect a compromise between an unbridled expansion of automation applications and a total refusal, based on misunderstanding, to apply automation technology to the benefit of all of us.

The objective of this Conference is to provide you with a sampling of the best of understanding, of concerns, of problems, of advantages and of the realities of automation applied to public service. Then, rather than believing any of us individually, you can form your own judgment and provide us all with the guidance we all need.

AUTOMATION TECHNOLOGY: KEY TO PUBLIC SERVICE PRODUCTIVITY IMPROVEMENT

KEYNOTE SPEECH
by
Thomas D. Morris
Assistant Comptroller General of the United States

The importance of revolutionizing our techniques and processes of delivering governmental services to the public is clearly demonstrated by the fact that during the lifetime of everyone in this audience, the United States has converted from a goods-producing economy to one dominated by labor-intensive services.

Eli Ginsberg, the noted economist and expert of human resources, sums it up this way:

> ". . . in 1920 the goods-producing sector--agriculture, mining, manufacturing, and construction--accounted for about three out of five workers . . . in 1970 it had accounted for only slightly more than one out of three."

He goes on to say that the difference "was absorbed entirely by the service sector, particularly by trade, personal, professional, and business services and government."

Governments at the Federal, State and local levels now employ 13,000,000 -- one out of every six American workers -- and have a payroll of approximately $149 billion. While public resources are squeezed between public demands for services and the rising costs of meeting those needs, there is growing resistance on the part of the public to providing more resources through higher taxes. One answer to this dilemma is improved productivity. The secret of doing more with the same resources is the substitution of capital for labor, in the form of mechanization, automation, and computerization.

The Federal Project to Measure and Enhance Productivity

Although there are a few instances of wide-spread automation today -- primarily in computer systems and mechanized paper handling -- efforts to automate services as a means of improving productivity, are difficult to find. This is due, in part, to the absence of meaningful measures of productivity in most of the services.

Over the past three years representatives of the Federal Government have been engaged in a research project aimed at learning how to measure and enhance Federal productivity. This project was started with a letter from Senator Proxmire to Comptroller General Elmer Staats in September 1970, stating that he found it "distressing that we have no real measures of the efficiency of the Federal sector." He then urged Mr. Staats to undertake a new assessment of the possibilities of measuring the productivity of Federal workers.

Mr. Staats had been a principal supporter of early efforts to measure Federal productivity in the 1960's. He decided the project was sufficiently important to deserve the combined attention of the three central management agencies -- OMB, CSC, and GAO. He invited these agencies to join him in a joint research project in an attempt to measure and enhance Federal productivity.

The final report of the team, submitted in June 1973, covered the design of a permanent productivity measurement system covering 187 organizational elements which employ 60 percent of the Federal civilian workforce. We found that the average rate of change in productivity between 1967 and 1972 had been 1.7 percent per annum on a cumulative basis. More important, a great deal was learned about productivity behavior in a wide variety of organizations, and the final report of that joint effort will be a useful contribution to the literature relative to organizational productivity.

Senator Proxmire characterized the effort as a potential breakthrough in better government management, and in a speech along these lines on May 13, 1974, Senator Proxmire pointed out that "for the first time in its history the Government has just begun to measure its productivity and has found that contrary to the assumptions of most economists it has improved year by year."

On July 9, 1973, the Director of OMB issued a memoranda to the heads of departments and agencies directing the continuation of productivity measurement and enhancement efforts, and spelling out roles and responsibilities. One of these responsibilities is the preparation of an annual report to the President and the Congress analyzing productivity trends and the factors which have caused productivity changes.

Productivity measurement would be rather meaningless if it consisted only of gathering statistics and adding up the results. The relevant questions are:

- Is the change which occurred the result of planned actions to improve either quantity or quality of performance? Or is it simply a happenstance result?

- What are the positive and negative factors which produced the result?

- How can we optimize productivity in relation to service to the public, accuracy of output, or other essential quality criteria?

- What will be the trend? What can we do about it now?

This study established that the single most potent influence on change was mechanization, computerization, and automation, and that these changes did not happen casually or overnight, nor would they fit just any situation. A dependable, predictable, and increasing workload -- such as has been experienced in population-related activities -- fosters this type of innovation. It was also clear that proper lead time and adequate planning are necessary to reap the real benefits.

One of the large categories of Federal activities that was examined as part of the productivity study will illustrate the importance of computerization.

Citizens Records Activities are Highly Automated

This group of activities -- representing 14 organizations -- maintains and processes records, at some time or another, on practically every citizen. It includes the Social Security Administration, Internal Revenue Service, Immigration and Naturalization Service, and the Selective Service System, among others. Collectively, it utilized 160,000 man-years in fiscal year 1973. Its gross output has grown since 1967. at an annual rate of almost 5 percent, while its employment growth has been held to less than 2 percent. This has resulted in a very respectable labor productivity increase, averaging over 3 percent a year.

The following are a few examples of how automation has significantly contributed to this productivity growth:

Social Security Administration: During the period of 1967 - 1973, the SSA saved almost 3,200 man-years as a result of automation. Some of the most significant actions included (1) direct input of data from the agency's district offices via telecommunications; (2) use of microfilm records in the district offices to reduce manual record-keeping using computer output microfilm (COM); and (3) encouraging health insurance contractors, employers, and others to submit data in machinable form.

Railroad Retirement Board: An arrangement was worked out with IRS and SSA to electronically furnish the addresses of over 40,000 non-retired railroad employees and the Board was able to eliminate all manual processing which would have been otherwise required.

VA - Department of Veterans Benefits: A major project is underway to develop a comprehensive ADP systems design which will automate all compensation, pension, and education, loan guaranty and insurance programs -- for which 5 million veterans are eligible. Continuing computer program refinements and the use of optical readers have contributed significantly to DVB's 26 percent productivity increase since fiscal year 1967.

Treasury - Bureau of the Public Debt: In the Savings Bond function, additional issuing agents are reporting issues on magnetic tape rather than by card stubs. Better productivity is achieved by magnetic tape input to the computer, as well as in the microfilming where stub images are developed from tapes by means of a Micromation Printer. Recurring annual savings resulting from this conversion in fiscal year 1973 were estimated at $135,000.

Out of the 14 organizations, all but three reported productivity gains, and most of these gains were the direct result of computerization. During the past six years, it is estimated that the 14 organizations responsible for citizens records have enjoyed cumulative payroll savings of over $300 million due to productivity gains. The organizations also learned that they cannot slacken their efforts; otherwise, they will reach a plateau, or even experience a declining productivity trend with the growth in data requirements being levied on them.

Federal Activities Need Timely Financing of Capital Investments

Our study team found that Federal managers in many cases have been discouraged from pursuing opportunities for productivity improvements having a fast payback due to the higher priority for programs or facilities concerned primarily with pollution abatement, health, energy, or safety.

To demonstrate the scope of this problem, the joint team obtained examples from a number of agencies and found 392 unfunded projects which would be self-liquidating in less than three years. Examples are

tape-driven machine tools, mechanized warehouse equipment, automated laboratory equipment, etc. Work on this problem is continuing under the guidance of GSA and a great deal of interest has been displayed in improving the capital budget process by the Joint Economic Committee.

Technology Applied to State and Local Governments

Since the Federal sector employs less than 3 million out of the 13 million personnel in the public sector, it is important that we ask: What is happening in State and local governments to improve productivity?

There is no simple source of such knowledge, but we are finding a great deal of effort and interest. The challenge is how to coordinate projects being sponsored by numerous Federal agencies, by the public interest groups, by the foundations, and by such public policy organizations as the American Assembly and the Committee for Economic Development.

One of the interesting current projects of NSF and Public Technology, Inc. is the Urban Technology System. This system is designed to apply research and information resources from throughout the Nation to the solution of problems in individual cities and counties. Experts -- called Technology Agents -- are being appointed in 27 localities. The system will be jointly funded by the Federal Government, the selected local governments, and other participating organizations. This is an imaginative experiment which could have high payoffs for large numbers of jurisdictions.

In addition to the agencies mentioned, there are many other significant efforts, which I do not have time to describe, being conducted by other organizations. We are all looking forward to the report on the service sector which has been prepared under Dr. Ruth Davis' leadership by the Federal Council on Science and Technology Committee on Automation.

Conclusion

As we examine this array of efforts to harness technology in maintaining the quality and reducing the cost of public services, it seems to me that we should stress three basic improvements in our management approach:

First, we need more and better measures of our performance -- both in terms of productive efficiency and benefits to the recipient. Without measures, we lack visibility as to our progress, or lack thereof, and the discipline to improve.

Second, it is apparent that we need far more effective techniques of correlating the numerous efforts now in progress or being contemplated. Without a focal point of knowledge, we may unknowingly duplicate our efforts, fail to establish logical priorities, and allow gaps to exist in our attention to the key problems.

Third, we need to foster imagination and encourage innovation. This Conference will undoubtedly make a significant contribution to these three basic improvements. I congratulate Ruth Davis and the Institute for Computer Sciences and Technology for their foresight in organizing this timely exchange.

ECONOMIC AND SOCIAL VIEWS OF AUTOMATION

A LABOR VIEW OF AUTOMATION TECHNOLOGY

by
Dr. Markley Roberts
Economist
American Federation of Labor-Congress of Industrial Workers

Workers and their unions have a vital interest in how computers, automation, and new technology get introduced into the workplace in order to be sure that people don't get squashed by technology. We are concerned about the possible destructive effects of technological change on workers and their jobs. We want to make sure that human values get priority over narrow considerations of economy or efficiency.

Much new technology has the effect of all labor-saving operations -- more productive with the same number of workers or with fewer workers. As a result, the introduction of automation often raises the threat of displacing some existing jobs and displacing some workers. No doubt there is creation of new jobs as new technology is introduced, but there is also elimination of some old jobs. There are changes in job content, in skill requirements, and in the flow of work.

Major technological changes often cause changes in industry location -- shutdowns of departments and entire plants and shifts to new locations in suburban or outlying areas. Sometimes the new locations are hundreds of miles from the previous locations.

We recognize that the introduction of new automation technology opens new opportunities for more and better goods and services at lower cost and maybe lower prices; and that new technology makes possible safer, easier, more satisfying work with higher pay and better working conditions. But it's also obvious to us that new technology opens up new problems in terms of workers' jobs and earnings.

For a worker, the loss of his job is a major catastrophe, a threat to the worker's income. It has a major impact on his investment in job-related retirement and health benefits, in seniority rights and work skills, in addition to threatening to wipe out his investment in his home and his community. For most people, their job gives them economic and social status in the community as well as income to support themselves and their families.

Job loss hits older workers, women, and minority workers with special severity because of discriminatory hiring practices, and the less educated and less skilled workers face extra handicaps in finding new jobs.

One absolutely essential component of our efforts to deal with the human problems of automation is collective bargaining. The American system of labor-management collective bargaining helps workers -- and the unions that represent them -- negotiate and settle with employers on reasonable and humane protections for workers against the potentially dangerous impact of job-destroying technological innovations. Collective bargaining can provide cushions to soften the adverse impact on workers by settling up adjustment procedures and programs at the workplace. In a full employment economy, the disruption of workers' lives and the job displacement resulting from technological change can be minimized.

Back in 1966 the National Commission on Technology, Automation, and Economic Progress pointed out that "Collective bargaining has proved to be an excellent vehicle for the effective management of change; it permits those directly affected by the change to deal with it firsthand and with a familiarity that takes into account peculiarities and problems peculiar to the enterprise."

More recently the National Commission on Productivity has pointed out that "A society that seeks the benefits of productivity growth is obligated to safeguard those who would otherwise suffer from these adverse effects. This can be done by such means as: avoiding worker displacement, mitigating financial loss of individual workers, assisting workers in finding alternative work."

There are no simple solutions to the task of protecting workers against injury from changes in automation technology. In thousands of labor-management agreements covering millions of workers, unions and employers have adopted a wide variety of provisions to cushion adverse impacts from technological change. These provisions fall into a few general categories which I will call job protection, income protection, fringe benefit protection, retraining, and relocation assistance.

The specifics include attrition or no-layoff provisions, early warning of change, seniority protections, early retirement opportunities, "red circle" pay rates, shorter work-weeks or work-years, relocation

rights to follow transferred operations, severance pay, and many other specific labor-management-bargained responses to technological change.

We have had much constructive innovation by the private sector on these problems of adjustment. We need much more constructive action in the public sector on these problems.

In the federal service there is no full collective bargaining. The scope of federal bargaining excludes wages and most regulations of the Civil Service Commission. The mechanics of the Federal Pay Council and the Federal Prevailing Wage Advisory Committee have not been utilized as effective instruments for collective bargaining, although the Postal Service and the postal unions show that collective bargaining for the federal service is both possible and viable.

At the state and local government level there is a mixed pattern of collective bargaining. In some areas a long-standing collective bargaining relationship has developed. In other areas there is a total management rejection of collective bargaining.

Without full collective bargaining -- no matter how enlightened or benevolent management is -- workers simply don't have a sense of participation in the basic decisions which govern their lives and their livelihood. Collective bargaining in the public sector and in the public services industries is essential to meet the challenge of technological change with a minimum of discombobulation.

It must be emphasized that a full employment economy is the key to successful, humane adjustment to the job-displacing effects of automation and technological change. There's no avoiding this basic issue. Only an expanding, full employment economy with increasing job opportunities for all who seek work can meet the needs and the hopes of America's working men and women and their families.

TECHNOLOGY, HUMANITY AND THE CITIES

by

Louis H. Blair
Senior Research Staff
The Urban Institute

Technology, humanity and the city are key factors to be considered in the application of automation to the public services. Are these factors compatible with one another? Can we meld technology into cities to improve humanity? Questions such as these emphasize the need to consider the societal impacts of technology in our planning and management. These concerns are why societal impacts have been the major thrust of a study by the state and local governments research program by The Urban Institute.

The primary question is how are societal impacts measured? What are the impacts on the city as a group of people? These questions must consider both the hardware technology and the software technology as they relate to the problems of the city.

In discussing technology, humanity and the city, it is necessary to deal with some of the apparent incompatibilities, the needs for planning, and the things which should be considered in the planning. The key point in such a discussion is that technology is not an end in itself, although it is a multi-billion dollar industry of vital importance to many people. Technology is a way of achieving certain things that our society considers desirable for civilization.

Humanity can be defined as a quality or condition of being human. Humanity can be thought of in terms of literature, philosophy, art, and the concepts which appeal to the psyche and contribute to the improvement of the quality of life.

The third factor is the city, a home of the citizen, a person with allegiances to the state or collective body. In evaluating the interaction of these factors, the typical attitude is that technology is responsible for the depletion of our natural resources, for the polluting of our environment, and that it is creating an alienation. Modern construction technology in the cities is an example. The high rise buildings of the cities are marvels of technology, but they tend to overwhelm personal interaction. There is little or no personal interaction in a high rise office building or a high rise apartment building. Modern rapid transit systems are marvels of technology, built to get people efficiently in and out of the places in which they work.

However, this technology has broken up the former environment of working together and living together, and has separated and fragmented our life. Cities no longer appear to be inhabited with persons with strong allegiances to the city. Instead, people flee to get out; they despise it; they dislike it. People no longer relate to one another; they are fearful, fleeing back to the simple life.

What does technology have to do with these attitudes? To a great extent, the application of technology and the way in which it has been managed has not been wide enough, hasn't been broad enough to really

completely encompass humanity and the city and its development. Technology has not been viewed as a process by which cities can be made better places, by which we can somehow increase our store of humanity.

It hasn't always been so, and there is no reason to think it always needs to be that way. A look back at the origin of technology is an appropriate way of reviewing out objectives. Evidence indicates that the first application of technology was in agriculture. Ten thousand years before man began to till the soil to increase his output of food, he was using tools for cultivating flowers to try to make life beautiful. Manufacturing and fabrication may have its origins in welding. Welding was developed by the Greeks to make more beautiful statues, larger statues.

Metallurgy is another key element in our technology today. It came about by people experimenting with various alloy processes for decorative effectives in armor. The technology of etching came about because people wanted to make more beautiful swords, not to fight with, but to possess things that really look pretty, that were satisfying. Travelers who have been to Florence, Italy, have some how sense that this humanity, this beauty is some sort of applied technology that is very appealing to the psyche.

In many cases technology no longer serves that purpose. Technology no longer makes the citizens feel much more together, feel that they live in a much more beautiful place.

Another key concern of today is public safety and it appears that earlier concerns of safety indicated the start of mechanization. An assembly line, developed to make locks, was an early example of precision engineering, and working assembly lines. It thus appears that we have lost sight of what our key objectives are. The research industry, the technology industry is now so large and complex, that individual engineers, scientists and technocrats and managers, can no longer perceive or control the progress of technology from the conception of research to its end application. But somehow the technology community has to become more aware of the needs of citizens, the actual impact of technology on citizens, on the community, and on the labor element.

The application of technology is not a simple operation. Every institution has experienced a great reluctance to adopt technology, even when its good. There is always a resistance to change in cities. On the other hand, many who send the people with technology solutions to us really don't understand the problems that the cities have. Frequently the technology proposed is not amenable to the problems that the politicians or the citizens sometimes face.

The benefits of proposed technology applications have not been well specified, nor have the implementation processes been clearly defined. Rarely, if ever, do the proposed projects or solutions consider the impacts on society. This Conference can have a lasting effect if it can focus on the fact that technology development and utilization should not be viewed as an end in itself. Instead, technology must be used as a means for improving the condition of cities and humanity, and to provide a chance and an opportunity for us to manage technology to improve cities, to improve humanities, and to make technology, humanity and cities compatible.

SESSION I: AUTOMATION FOR URBAN PUBLIC SERVICE OPERATIONS

Chairman: Joseph M. Carlson
Assistant to the Senior Vice President
Public Technology, Inc.

It is quite appropriate that the first major session of this Conference is directed to the role of automation in the delivery of public services by local governments. The recent trend toward the devolution of federal responsibilities to the state and local levels which is explicit in the new federalism and general revenue sharing policies carries with it increasingly larger responsibility for service delivery. The increase in responsibility is occurring in an atmosphere of increased demand for public services coupled with increased costs attributable in a large part to inflation. The resulting circumstances require that local government officials increase their effort to stay abreast of all developments, whether in management or relating to technological change, that can aid them in meeting this service delivery demand. Likewise, they are faced with a need to seek a rational basis to realistically evaluate the potential, including both cost and benefits, that the new technological developments are said to offer. They must also be innovative and in many areas must take the lead, in developing new approaches to their problems, and in developing new applications in local government for technology, which in some cases is originally intended for other sectors in the economy.

Carmen F. Guarino
Commissioner and Chief, Water Department
Philadelphia, Pennsylvania

The Philadelphia Water Department supplies complete water service for the metropolitan Philadelphia area with a population of over 2 million people. The service treats and distributes an average of 363 million gallons of pure water each day through 3,200 miles of pipes of various sizes. After treatment and distribution, the Department is responsible for wastewater collection and treatment, requiring over 2500 miles of sewers and three wastewater treatment plants.

In order to provide excellent water quality and insure public health in wastewater treatment, the Department is currently involved in improving the water treatment plants and upgrading the wastewater treatment plants, operations in which automation is considered a vital factor.

Water systems of this size are extremely complex things to efficiently control. Both water and wastewater treatment plants have become very sophisticated installations. Distribution and collection of the vast quantities mentioned earlier has also become much more demanding in recent years. Fortunately, the advances in computer technology are providing the necessary techniques for controlling both processes.

For example, we are monitoring the quality of the river water by using a satellite that passes overhead in Philadelphia, twice a day. The Schuylkill and the Delaware River are monitored by 20 stations that gather data that is sent up to the satellite as it comes overhead. By means of this system, we are able to obtain real time data about the pH, the dissolved oxygen, the temperature and the flow at 20 points on the Delaware and the Schuylkill.

Automation provides the capability of rapid communication and data handling. This aspect furnishes the added advantage of centralized monitoring. In the water distribution system, Philadelphia is currently operating a load control center. This center is a panel display with alarms, switches, etc., that shows flows and pressures in the water piping system. The flow and pressure are monitored at various points throughout the system and readings are sent to the load control center via eight microwave transmitters.

We are able to monitor the pressure throughout the system, and we are able to operate the 17 pumping stations to change the pressure. We are also able to monitor the chlorine content as well as the contents of all of our reservoirs. This system allows the Department to quickly determine areas of low pressure or possible main breaks and take appropriate measures to correct any malfunctions. The load control system has also improved the distribution by decreasing the response time to correct malfunctions.

We use computers to simulate the process, and to provide some near-real time process control, and some on-line process control. The NELOG program records 400 pieces of information every day. All significant events at the Northeast plant, the Southwest plant and the Southeast plant, are put into a computer data

bank. Once it goes into the computer, it can be used to provide many types of information previously unavailable. In fact the design of new plants are based on this data that is furnished to the consulting engineer so he can design a better treatment plant.

Philadelphia has also been active in developing control schemes for various wastewater treatment unit operations. Now in use at our Southwest facility is an automatically controlled sludge pumping system that uses an in-line density gauge with upper and lower set-points to maintain the proper thickness in sludge pumped to the anaerobic digesters. Experimental work has also been done using dissolved oxygen probes to pace mechanical aerators in the aeration tanks at Northeast. Work has also been done with pH meters, turbidometers, level detectors, etc., in the past several years.

The main deterrent to full automation of the water system are the sensors necessary to pace the various processes. Sensors capable of withstanding the harsh wastewater environment, for example, need much more development before they can be used in a full-scale, continuous operation. Instruments to rapidly determine such chemical parameters as BOB, COD, TOD, TOC, etc. are only now beginning to appear in the laboratory. These devices detect pollutant loading to some degree and could be used in plant operation if they can be adapted to continuous application. The major problem in most cases is developing a suitable on-line blending system and sample delivery mechanism. Until these obstacles can be overcome, online use of these instruments is not possible.

Although the general concepts for computer controls have received much attention and study during recent years, the actual implementation of these concepts to specific plant applications can involve detailed and sophisticated computer procedures. No two wastewater treatment plants are alike, and their variations and unique characteristics must be programmed into the control scheme.

It is anticipated that the equipment in the modern treatment plants is going to change. For example, a new wastewater treatment technique is called the biosurf. The biosurf is a very simple method of treating wastewater, using about one-half the power used by conventional processes. If the design of the Northeast and the Southwest plant were not so far along, I think I would consider the biosurf system for those two treatment plants. The equipment is principally a drum that rotates in the wastewater. Instead of having to buy the oxygen or make the oxygen or blow the air through the sewerage, the drum simply revolves and obtains the oxygen free from the air. The drum is coated with biological slimes, and these biological slimes remove the BOD as it comes through the drum. It's a very simple process that requires very little supervision.

Since each wastewater treatment plant is a unique entity, the first step in plant automation is a comprehensive evaluation of current plant operation procedures. By reviewing with the operators their observations and insights, one can get some feeling for the logic being utilized for plant control. Since most operators have developed their skill through years of experience, their ideas combined with historic data can provide the initial basis for process control. These control schemes will have to be extensviely verified through case testing prior to their direct utilization for plant control.

A great deal of encouraging development work is being conducted but much remains to be done. Hopefully, the material presented here can show the potential for automation in water supply systems and help to establish development priorities so that better control systems may be realized in the near future.

Warren E. Isman
Captain, Fire/Rescue Services
Montgomery County, Maryland

The average citizen normally has only a casual experience with his community fire department. This experience might include taking the children to the fire station during fire prevention week or watching as firemen fought a fire.

Perhaps, when the firemen asked for a pay raise or the volunteers collected donations for a new pumper, a thought might cross the citizen's mind concerning their job function. But, caught up in the many other problems of today's society, the thought is quickly forgotten.

Therein, in very simple terms, lies one of the great problems of the fire service. The fire and rescue service of this nation is centered on manpower, yet little effort from the outside has been expended in trying to solve the problems. Every solution from increased alarms to improved fire prevention programs is answered by the cry, "More Men."

The fire and rescue service is beginning to explore alternative answers to more manpower, spurred on by governmental funding of research, angry taxpayers upset by their increasing burden, and Federal laws such as OSHA.

For example some effort is being focused on the area of automatic dispatching. Dispatching requires instantaneous decisions by a dispatcher based on the following information which he must retrieve manually.

- Closest companies available for response.
- Closest unit if the apparatus is on the road.
- The status of the apparatus - (a) ready for a call in station; (b) not available because at a fire; (c) ready for a call returning from a fire; (d) or out of service.
- Companies that have specialized equipment such as special rescue tools.
- Location of hydrants that are out of service.
- Streets and areas that are closed to traffic.
- Cross reference between names of buildings and their addresses.
- Status of internal fire protection systems, such as standpipes and sprinklers.
- Number of people living and/or working in the building.

After completing the manual retrieval operations, the dispatcher then alerts the necessary stations, and provides a location, so the apparatus can respond.

In Montgomery County, Maryland, this type of dispatching was repeated 45,000 times during 1973 indicating the enormity of the problem. To cope with this problem, some communities such as the Burough of Brooklyn in New York City now have a partially automated dispatch system.

However, additional improvements are possible. For example, a recent article in IEEE Spectrum described an automatic emergency vehicle locator system. This system kept a constant update on units in the field by a triangulation method. A continuous readout on a map provides the dispatcher with availability and location of all apparatus. Another advance in the area of emergency response is the automatic system of turning traffic lights red on the streets of travel to the fire scene, which provides a quicker, safer response.

Firefighting equipment has also been improved, such as remote control of large stream nozzles. These nozzles, placed on the end of an aerial ladder can be controlled from the ground to change the pattern (solid or fog) and control technique has removed the firefighter from a vulnerable position on the end of a ladder to a safe position. For special application a small remote control track vehicle has been developed which can carry a nozzle and hose, unmanned, into the fire.

However, one of the more promising applications of automation for the fire service is a result of the combined efforts of Grumman Aerospace Corporation and Public Technology Incorporated to develop an automated pumper. In traditional firefighting operations, one of the major problems is the need to keep an operator at the pumper at all times to control the hose lines.

On an average single family dwelling the normal response is two or three pumpers usually undermanned. Each pumper has a driver who remains with the equipment. Thus, three people are lost to the fire suppression effort.

While the pump operators' main job is to provide the correct quantity of water to each nozzle, he must also monitor the engine parameters such as oil pressure, water temperature, and battery conditions. He must also control the equipment to ensure that sufficient water is being supplied to the pumper, to change the flow such that when one line is shut down the other lines are not overpressured, and finally that the pump does not overheat.

Concurrently the firefighters at the nozzle also have problems. The man at the nozzle knows how much water he needs to extinguish the fire, but in order to increase or decrease his supply he must either radio back to the pumper operator or send a runner. This is usually a hit or miss proposition, up a little, down a little, with the additional hazard that too high a flow at the nozzle can cause over pressurization and knock the nozzleman off his feet. Serious injuries have resulted from just such an action.

A fully automated pumper, then, offers some very attractive advantages.

With a broad agreement on what the problem was, Public Technology acted as the catalyst to bring together the fire service with an industrial organization interested in performing the research and development. PIT established a User Design Committee with the following mission:

- Define operating parameters.
- Explain operating conditions.
- Review specifications.
- Look at safety aspects.
- Review prototype design.
- Provide input for marketing strategy.
- Provide test and evaluation data.

The data obtained was used to define the Grumman system. In this system, after the pumper has been connected to a water source, the automatic control is turned on and the water governor control is set. The fire hose which is easy to handle since it is empty, is now stretched to the fire scene empty. When the line is in position, a collar attached between the end of the hose and the nozzle is rotated clockwise in predetermined steps to increase the flow. Turning counterclockwise decreases the flow in these same steps.

The control signals are sent to the pumper by a transmitter which sends out a digital code each time the collar is rotated. A receiver/decoder at the truck "reads" the signal and opens or closes one of the constant flow valves. The use of constant flow valves also overcomes the need for calculating pressure losses due to length of line, losses due to elevation, etc. Instead, the system increases flow automatically until the requested flow is obtained.

Should one line be shut down the automatic governor adjusts the flow so that none of the other lines will receive any overpressure. When a line breaks, water flow is not affected in the other lines in operation because the pumper automatically continues the requested flows.

Engine conditions are also watched over automatically. Pump speed, oil pressure, radiator water temperature, and battery condition are all continually monitored. Should a malfunction occur, a distinctive audible signal is sounded, a light on the control panel lights indicating trouble, and the hose line is pulsed at one second intervals. The audible alarm alerts firefighters in the area to the existence of a problem, and the pulsing line warns firefighters inside the building that they should back the line out.

Should the water intake decrease, the flow in each line is cut back one step at a time until stability is achieved. In this way, no line is shut down while operating in the fire area.

The automated pumper should provide a significant improvement in fire fighting performance. Firefighters will be more productive through better utilization of manpower and safety will be enhanced through better control of the water supply.

In assessing possible applications of automation technology it appears that the retrieval of prefire planning information is a good candidate. A fire department spends many man-hours making building inspections, and this information should be made available to the firefighters when a building has a fire. Such a retrieval system could indicate:

- Location of fire protection devices.
- Special hazards within the building.
- Ventilation locations.
- Utility controls.
- Type of occupancy.

Some additional applications of automation technology appear to be feasible in the following areas:

- Automating some of the many hundreds of rescue and ventilation tools currently used by fire departments.
- Eliminating the need to place a man on the roof in jeopardy by having him cut ventilation holes.
- Ventilation of windows in a high rise building that don't normally open.
- Systems to dispatch apparatus and keep track of equipment once on the road.

- Special equipment to fight fires in hazardous areas (railroad incidents, chemical spills, etc.) without endangering personnel.

- Automated system operating inside a building so that should the building collapse, no firefighters are killed.

The fire services have turned the corner and are now ready to work in these areas. There are many who stand by ready to assist in the solution of these important problems.

Marc G. Stragier
Deputy City Manager
Scottsdale, Arizona

Introduction

Refuse collection provides a most relevant case study of what can be done to meet the many divergent needs of labor, management and most importantly, the consumer. In applying automation and technology in public service operations, there is certainly no lack of motivation for applying automation technology to refuse collection. Let's examine five major motivations in regard to refuse collection:

1. Providing Services in Hazardous Environments: The Police Chief who justifies a budget increase for patrolmen who "daily put their lives on the line for the citizens of this community" doesn't mention that his accident rate is only half that among refuse collectors. The National Safety Council has shown the number of disabling injuries per million man-hours worked is 98.9 in the refuse collection industry, 53.24 in police work, 32.96 among firemen. It is obvious that if there was ever an area for improvement of a "hazardous environment" refuse collection would be it.

2. Providing Services that are Tedious, Boring or Demeaning: Refuse collection more often is performed by underqualified people than any other municipal service. When one collector is required for each 1000 population, it is difficult to find enough good men. Some cities have reduced employment requirements to qualify physically, mentally and morally unfit persons. We, in this area of public works, are performing the most expensive, most personal, most public service our city provides with less than adequate employees.

3. Improving Quality of Service: Although citizens hear more about their police service, they are usually involved more with refuse. Police or Fire can make a major shift in service policy without notice from the public. Make a shift in refuse collection service and the switchboard lights up like a Christmas tree. Since every citizen sees it in action and since it is a personal service, citizens tend to judge their municipal government by its refuse collection service. The mechanizations we will discuss here have always improved service and citizen attitudes.

4. Increasing Accountability Demands: Usually the cost of refuse collection is more than twice the cost of police or fire protection. Cities will boast that they are holding fire protection costs to $10 per capita but they don't mention that their refuse collection costs are $20 or more.

5. Providing Services Faster than Human Capacity: In addition to the dangerous, boring and demeaning nature of refuse collection, it is hard work. Human capacity is limited not only by physical strength and endurance, but by the elements -- extreme heat, cold, wind, rain, or snow.

In summary, there is no area of municipal service more important to all of the citizenry than refuse collection. Yet there is none more expensive, none more difficult to find qualified employees for, none more hazardous, than refuse collection.

The Coming Revolution -- Mechanized Collection

Refuse collection is entering a new era of development. Emerging from the old methods of can-truck-dump are the new systems of mechanized collection with their accompanying advances of increased safety, savings and sanitation. The mechanized collector is a new breed who never leaves his air conditioned cab. The mechanized system he uses is less costly, more sanitary, safer, more productive and popular than conventional collection. The work being done by various cities supports these conclusions.

Description of Mechanization and Progress to Date

The following presentations provide some comparative statistics and summaries of the various systems. Consideration of each is warranted. Conventional collection is provided typically by rear loaders manned by three-man crews. This standard conventional system is used as a basis for comparison in the tabulation. The crew consists of a driver and two workmen who handle a multiplicity of cans, bags and other containers supplied by the customer. Containers or bags are emptied or placed in a hopper and compacted into the truck. Collection costs is about $3.71 per home per month.

Fort Lauderdale's System - A simple modification kit is attached to a rear loader which elevates containers equipped with wheels. They are rolled to the lifting device, placed on a small frame by the loader, who then activates a control to raise, empty and lower the container and then removes the container placing it at the curb. This device is identified in the tabulation as a modified rear loader and costs about $3.47 per home per month including the 80-gallon container it serves.

The Barrel Snatcher is the workhorse of the Scottsdale's system. It collects the 300-gallon containers in the alley at rates up to 100 per hour. It is a 35-cubic-yard packer body with a telephone booth type cab beside the engine. The sturdy 8-foot manipulator attaches on the right side beside the engine and telescopes out to grasp containers as much as 12 feet from the truck. Containers are grasped and dumped overhead into the body. Electric switches attached to the one-hand control handle operate solenoids to perform the various hydraulic functions. The Barrel Snatcher costs $1.54 per home per month on a comparative basis.

The next mechanization is called the Litter Pig by Scottsdale, where it is in regular use. The Litter Pig is equipped with a telescoping arm loader that can be manipulated by controls from the cab to reach out and grasp 80-gallon containers placed at the curb. The telescoping arm unit is bolted to the body adjacent to the loading hopper. Without leaving the cab, the operator can position the barrel-gripping hand to engage a container located anywhere in a 30-square-foot reach area. The Litter Pig costs $2.25 per home per month for twice weekly service.

Godzilla is a standard front loader converted to pick up Scottsdale's containers. It is slow and might be practically used as a back-up truck. It costs $1.82 per home per month, including 300-gallon containers for alley service.

Tolleson's System - Tolleson Arizona is using a non-stop collection system. The truck serves 55-gallon drums hung on a special bracket. Each drum is equipped with a small sheave at the lower corner on the alley side. The truck is equipped with a cam rail, which the operator merely inserts into the sheave. Refuse falls from the container into the receiving hopper from which it is swept and compacted into the truck body. As the truck continues, the cam rail guides the sheave down again and the container returns to its normal vertical position. Comparative costs of service in Tolleson is $1.57 per home per month.

Bellaire's System - Bag collection by mechanized equipment was developed for Bellaire, Texas by Gulf Oil Company. The mechanization has been in productive use for a number of years. It is a standard 20-yard sideloader truck equipped with a special conveyor and an articulated arm. The backhoe style arm carries a large basket and suspends it over the load. The truck features one-hand controls that can collect from either side and is productive in the hands of a skilled operator. Collected bags are placed on the conveyor belt over the front bumper and conveyed back to the body. Gulf has offered to furnish the truck to agencies which will purchase their plastic bags for collection service. Comparative cost is $2.48 for twice a week service including the supply of bags for each householder.

Mechanization is a fact and already offers the advantages of economy, safety and popularity. A glance at the tabulated costs shows that mechanization is already saving Tolleson, Scottsdale, Fort Lauderdale and Bellaire about $6 per capita per year. Thus cities with a population of 60,000 could save $1,000 per day.

Scottsdale and Tolleson have both done attitude surveys which show strong citizen support for mechanized systems. The improved safety and working conditions make the system popular with workmen. Needing one employee for each 6000 population instead of each 1000 makes recruitment simpler and workmen easier to find.

<u>Tabulated Comparison of Operating Characterists of Various Collection Systems</u>:

The following table is based on salaries, fringe benefits and working conditions in Scottsdale and may easily be modified for use in other areas. Figures are based on direct costs using a 172-hour work month, 60-minute haul time, twice a week service. Comparative cost of service can be determined from the following formula which was used for this analysis:

$$\text{UNIT COST} = \frac{(\text{Pickups})\ (\text{Operation})}{(\text{Workhours})} \left[\frac{(\text{Capacity})}{(\text{Capacity})} + \frac{(\text{rate})\ (\text{haul})}{(\text{rate})}\right] + \text{Container}$$

where: <u>Unit Cost</u> is the cost of service in dollars per home per month.
<u>Pickups</u> are the number of collections provided per month or 4.5 for once a week and about 9 for twice a week.
<u>Operations</u> are the total cost of operating a collection vehicle for a month in dollars including amortization, labor, maintenance, fuel, crew, driver and any overhead.
<u>Capacity</u> is the number of homes served for each load to disposal in homes per load.
<u>Rate</u> is the number of homes collected in a normal hour of collection with no allowance for hauling.
<u>Haul</u> is the average haul time in haul time per load.
<u>Hours</u> is the number of hours worked per month, and includes both collecting and hauling hours.
<u>Container</u> is the monthly cost of providing containers as part of the system.

COST PER HOME PER MONTH
SELECTED COLLECTION VEHICLES

Vehicle	Container	Crew Size	Size in Cu Yds	Collection Rate	Container Cost	Once/Wk Collection Total Cost	Twice/Wk Collection Total Cost
Rear End Loader	Household	3	25	85		1.86	3.72
Modified Rear Ldr	80-gal.	2	25	90	.54	1.93	3.31
Godzilla	80-gal.	1	28	58	.54	2.10	3.64
	300-gal.	1	28	160	.36	1.10	1.82
Litter Pig	80-gal.	1	22	131	.54	1.40	2.25
Barrel Snatcher	80-gal.	1	35	61	.54	2.28	4.01
	300-gal.	1	35	271	.36	.94	1.54
Shu Pak	Household	1	25	80		1.14	2.26
Modified Shu Pak	80-gal.	1	25	100	.54	1.51	2.47
Non-Stop Truck (Tolleson)	55-gal.	1	12	174	.32	1.22	2.12
Mechanical Bag Retriever (Bellaire)	Plastic Bags	1	20	140	.91	1.83	2.73

All of the data points to the fact that mechanization of refuse collection is feasible, economical, and desirable in terms of service, savings and satisfied workers and customers.

Donald S. Wasserman
American Federation of State, County and Municipal Employees

Public service employees, and unions that represent the employees, generally welcome automation. Automation can be viewed in two ways. As workers, automation can be viewed as a means for removing some of the drudgery from some of the common place employment in public service. Public service employees must also view automation as consumers and tax payers. Where these two views might be similar in one area, they may conflict in other areas. For example, most of the experiments in solid waste collection are taking place in communities in the southwest, and in the far west. The automated solid waste systems are being used in areas with relatively temperature climates, areas of suburban communities, areas that are readily adaptable to change.

On the other hand, the areas in which improvements are needed most, the areas which present the most difficult and troublesome challenges are not the small sparsely populated communities, but rather the large densely populated urban areas. The major problems are in the inner city areas where far too much time and far too much effort must go in to everyday considerations like solid waste collection.

In examining many urban situations, it seems that the most elementary steps for better organization of government must be taken before some of the more exotic concerns of automation should be considered. As a matter of fact, it seems that many governmental operations have not yet reached the stage of mechanization, and are really two or three steps removed from the introduction of automation. One we have not organized for it, and two we have not yet in many services even introduced mechanization.

Yet I speak without any hesitation from the very parochial interest of representing employees who work for state and local governments. When there is any discussion of doing things differently in the public sector, task forces are usually created within a governmental structure to study the problem., It has been our observation that these task forces usually neglect to obtain any input from the non-management employees, who will be directly affected by the prospective change. Consequently the task force will make recommendations that will be adopted, and implemented before there is any discussion or consultation with those whose jobs will be directly affected.

The fallacy of this approach to the conduct of a study is that very frequently, we find that those people who are most closely associated with the job are better able to solve the problems than those who are further removed. Not surprisingly, workers performing day-to-day routine jobs are in a knowledgeable position to make very substantial contributions in introducing change to those jobs.

All too frequently changes in the public sector are also accompanied, as they are in the private sector by little or no thought given to the impact on the people who are going to be directly affected by the change. For example, one state has a law stating that people who's livelihood are affected by changes in the state service are entitled to a retraining program. However, this kind of legislation is noteworthy, because of its uniqueness. Generally speaking, the concept of employer obligation for retraining for jobs is much more advanced in the private sector than it is in the public sector. This may be because representation for employees in the public sector is a relatively recent condition. However, the current trend indicates that the introduction of automation technology in the public sector, can only be accomplished if workers are consulted about the manner in which the technology is going to be introduced. This means that in many areas, the employees who are directly concerned will have a strong voice determining the extent, the degree, the methods and the manner in which changes will be made. This will be a major change because this means that employees will have some voice in what had previously been a unilateral management function.

One last observation. Very frequently inadequacies in public service in terms of directing the work force, in terms of the introduction of new processes, and new procedures is "fixed" very rapidly in an attempt to make up for past deficiencies. For many workers, these fixes are intolerable. The rapid introduction of change, the rapid introduction of another way of getting the job done are decisions in which discussion and consultation with the worker is absolutely necessary and must take place prior to the change.

James McManama
Director, Data Processing Center
City of Dayton, Ohio

When Dayton decided to take on the USAC project, the first step was to visit other installations to become informed on various systems. These visits developed a lot of bits and pieces about automated systems. Some systems were very good, and some were a waste of time. Since the development of full computerization of finance systems has been very slow, many systems are still primarily oriented toward the high volume repetitive type functions. Typically, the computer is used to crank out paychecks at 1500 lines per minute and is an excellent system.

However, when management requests information on the overtime hours for the last month by cause, by agency, and by function, the payroll people will advise management that is not payroll's problem, that is a personnel function; payroll only creates paychecks.

In most installations, computers have been for straight-up data processing applications. The data processing systems have been designed, developed and implemented one at a time, even in many instances where cities have multiple applications. Since they were brought up one at a time, the data processing systems do not tend to relate to one another, particularly if the data processing activities are decentralized. For example, the police department will get a system through LEAA, and the finance department will get a data processing system because the finance director threatens to prohibit the city council from spending any money unless they buy a computer for his department and besides the city down the pike has one so we need one also. So two systems are developed by separate organizations that don't talk to each other.

A typical example is a recent situation observed in a fairly large city. On one floor the finance data processing system was being used for property tax collection within the city. It was a very good online system, where transactions were being posted as they occurred, and changes in property were being put in the system. The data bank was up to date, and included complete land orientation, and an excellent geographic base file. It contained complete property descriptions, lot numbers, street addresses, information that could be accessed by street.

The same building also housed the police department. This department was preparing to enter into a $300,000 computer system to develop a street oriented file so that they could validate street addresses when an inquiry came in or a call for service was received. The police department was on the third floor of city hall, and the system that could respond to their needs was on the first floor of city hall.

We are currently interested in using our computer system to get more history of our water system so we can do some correlation studies. One of the things we are interested in is utilization. We have to have water consumption data to create a water bill. After that, it's a simple calculation. We use so many cubic feet, and that times rate is the charge.

However, a study on water consumption versus the income levels by geographic area may be of significant importance. We want to determine if there is any correlation. We have a hunch, backed up by our water department, that increased consumption equates to reduced income, because in certain areas, there is a large number of non-owner occupied houses. The tenants either cannot afford a plumber or do not care about leaks. Therefore, consumption increases.

This data may be a key indicator that a given geographic area is going down hill.

A large number of cities, including Dayton, have not installed management information systems as such. The usual procedure is to look at an operating system, automate it, and then look at the next operating system, and automate it. There is really no effort to determine cause and effect of information flowing through the various operating units, and there is usually no relation of one system to other systems.

The finance system that Dayton is developing is a horizontal type system. It is not organizational dependent, in that it is not structured along organization lines. Rather, it is structured along the functions that are being performed. For example, for accounting purposes, there needs to be charges compiled for payroll costs. It appears logical to create those when the payroll is run, and to do it by program as well as by traditional line and fund type system.

This approach establishes the system on a common data base. We took a look at several data base management systems, and we found them to be very expensive. So, Dayton established a series of linked files to identify where data elements are created, where they are accessed and where they are updated within a system.

Looking to the future, we want transferrable systems following the USAC concept of building functional systems that are transferrable. We need systems to automate the fire department, and our service department, which includes building inspection. At the present time there is no indication that when a tracking system is designed to follow up on permit applications and inspections, the fire department will be consulted to find out how a new building will impact on the fire department's procedures. It's predicted that this information will stay safely within the building department's system unless we work on an overall system.

We need to consider system in terms of functional problems. In some instances we need to define the functional problems. Within Ohio, during the decade of the 60's, Dayton had a reputation of being one of the finest cities in the state from a service delivery stand point, but the city blew up. Dayton had a riot. The city wasn't paying attention to things that should have received close attention. We were overlooking the people problems, and they were the ones that rioted.

What in fact should we be doing? What should we be addressing? Dissemination of technology is extremely important. We have a number of people in our city who are experts in their field. They are professionals in running a street maintenance division, running a patrol unit and a police department, and a fire fighting unit. Until recent times there was no opportunity or need for automation technology to correlate people-oriented data, to identify just what functions are being performed vis-a-vis what should be done, the costs of those functions which cross the classic organizational lines, etc. There is now.

SESSION II: AUTOMATION FOR OCCUPATIONAL WELFARE

Chairman: John H. Stender
Assistant Secretary of Labor

A discussion of automation and the welfare of the worker excludes total automation, where virtually all functions are taken over by machines. This discussion will therefore concentrate on partial automation, where automated equipment and techniques are used to augment the worker.

The application of automation to industry -- whether public service or private -- is, of itself, neither good nor bad. It can be either. The possibility of concern to us is the fact that automation has the potential for displacing large numbers of workers. This is nothing new, because machines have been displacing manpower for years.

For example, today only about 7 percent of the Nation's work force is engaged in farming. Yet our farms produce more food and farm products than ever before, while farm employment continues to drop.

But what has happened to the workers no longer employed on the farm? Obviously, most have found jobs in other industries. The substitution of machinery for men, then, has at least one major effect. It frees labor for other tasks.

The process is not limited to farms. A long trend in manufacturing and office work is towards fewer workers to accomplish more work. Machines have again made this possible. Even today's housewife sometimes feels "less needed" because machines have taken over many of her more routine tasks, and given her free time she never owned before.

The trend of substituting machinery to do man's work is not going to be reversed, and we don't want it to be. Machinery has increased our productivity and made possible today's high standard of living. Continued gains can only be made possible by continued substitution of machines for men.

But automation -- some call it the second industrial revolution -- goes beyond machinery to include substituting entire operations controlled by machines for processes formerly done by men. This has been made possible by today's small-unit, low-cost computer technology that, in effect, gives machines decision making capabilities.

The speed at which automation occurs, and the extent that it occurs within an industry, is a major concern. For example, it is quite possible that entire classes of skilled and semi-skilled workers could be replaced by automation within a single generation. Linotype operations, sterotypers, photoengravers, electronics assembly workers, lathe operations, and even warehousemen are just a few examples of workers whose jobs could dry up because of automation.

Such large scale displacement of large numbers of skilled workers would require adjustments within the economy. Industry and government retraining programs would be one approach. Early retirement programs is another possibility. Large, one-time, lump-sum readjustment allowances is another.

In any case, care must be taken that the purchasing power of the economy is expanded to make it possible to absorb the increased productivity made possible by automation, or the benefits of automation could be negated by economic recession.

If automation poses economic hazards for workers and the economy, it also promises benefits. For example automated techniques are being used in operations taking place in environments that are unsafe for humans. Other applications that would benefit us include high-temperature work environments such as large component forging operations, operations in radioactive environments, in chemically-polluted environments, and operations requiring heavy lifting and moving.

More importantly, automation promises to make possible operations in environments so hostile to humans that, at the present, they are beyond our reach. For instance: ocean-bottom mining and energy reclamation; space exploration and mineral excavation on the moon and other planets; deep-earth mining.

In the public service application, automation can be used and is being used to supplement workers and increase safety and health right now in many day-to-day industrial and service operations.

Manufacturing, particularly punch press and die operations, welding, and glazing processes can be made safer by substituting remotely controlled machines for men. The same is true in chemical processing

operations where the chemicals are potentially harmful to employees. Power-generating plants, metal refining operations -- especially steel -- all can or already have developed ways to substitute automation for manpower and, in doing so, reduce safety and health risks.

Automation also has the potential of eliminating many dirty, demeaning, and unpleasant jobs, and, at the same time, creating new and more satisfying ones.

By increasing productivity, automation may result in a shorter standard work week . . . It may be possible to reduce the work week to 10 or 20 hours, without reducing the workers standard of living.

All of these benefits -- and the same risks mentioned earlier -- apply to public service workers as much as for private industry.

Automation is already in use in many public service areas. Police have been using computers for years. Fire Departments -- and Dr. Atwood will go into this in much greater detail -- have been seeking automated equipment to make fire-fighting safer and more efficient.

Sophisticated teaching equipment is being used in schools, not to replace teachers, but to make them more effective.

Even the humble traffic light is an example of automation applied to public service. Self-regulating, traffic lights have freed police to use their time for other, more important business that can't be done by machines.

I think we can safely say now that the increasing complexity of our world, the increasing demand for energy and raw materials, all point toward a greater government role in many areas in the future. From space exploration and development, to the quest for energy and resources deep inside the earth's crust or on the ocean floor, the challenge is in front of us.

These challenges lie beyond the grasp of naked man -- both in his ability to survive and his ability to produce efficiently. But they do not lie beyond the ability of augmented man: a reasoning man at the helm of an automated system.

As I said at the beginning, automation in and of itself is neither good nor bad. It's what we make of it that counts.

The worst thing we could do now would be to do nothing -- to ignore its potential, to not plan for its use or introduction.

Dr. Roswell L. Atwood
Director of Education
International Association of Fire Fighters

Fire fighting is the most hazardous occupation in the United States today. For the past 15 years, the IAFF has been compiling figures on deaths and injuries sustained in line of duty. For the past 7 years these figures have been based on questionnaires sent to chiefs of fire departments. They are, therefore not union figures but are management reports and, no doubt, reflect the minimum amount of injuries.

We define an injury in these questionnaires as one requiring medical attention. In light of the sources and the definition implied, we find that fire fighting is increasingly hazardous. The last survey which reflects the experience of 1972 and was published in November of 1973 showed that fire fighter injuries were 47.8 out of every 100. This was an increase of 10.1 from 1971.

No one knows precisely how many fire fighters there are in the United States. We know that there are some 280,000 full time professional fire fighters and it is estimated that there are some 1,250,000 volunteer fire fighters. The reason for the vagueness is that there is no one central body to assemble data for the volunteers. Consequently there is no information as to the number of deaths and injuries sustained by the volunteers. However, 3 years ago, I made a survey of a sampling of volunteer fire companies within a radius of 50 miles of Washington, D. C.; and I found that the number of deaths and injuries among the volunteer fire fighters surveyed, was just about the same as our figures at that time for professional fire fighters. If we extrapolate these figures to applied volunteers, there may be as many as 597,000 injuries sustained by the volunteer fire fighters in the course of the year.

There is no other occupation that has any where near this number of injuries. If we look at some of the causes of these injuries, we find that between 1971 and 1972, there was an increase of 58% resulting from over exertion and that sprains and strains increased 79%. There are several reasons for these drastic increases in injuries to fire fighters. We believe that one of the reasons for these drastic increases, is that most of our larger cities are running fire departments that are undermanned. This requires fewer fire fighters to do the work that normal man power allotment would perform.

But there are other reasons for this high incidence of injury to fire fighters. For example, there is the matter of fire fighting equipment. The report of the National Commission on Fire Prevention and Control, entitled "America Burning" has the following description: "Smoke is pouring from the windows from a vacant apartment on the third floor of a tenament. A passer-by runs to the nearest fire alarm box and pulls the lever. Instantly a gong sounds in the fire station 8 blocks away, the pattern of its ringing, indicating the location of the alarm box. Fire fighters jump into their heavy boots, don their helmets and canvas coats and sprint abroad a pumper. Other men board the ladder trucks sitting next to the pumper. In less than a minute after the sounding of the gong, the pumper and the truck are racing down the street toward the fire, their sirens wailing. Simultaneously, engines from other fire stations head toward the fire. This is a scene that is repeated hundreds of times a year, in every city. Except that internal combustion engines have replaced horses, this is the way fire departments have responded to fires for as long as anyone can remember. Seldom does the question arise, is this the best way to respond?"

The Commission goes on to ask the question, how can fire protection be improved? The answer provided in the report suggests that the solution is in the careful assessment of future investments in men, equipment and new programs. I should like to comment on some of the possibilities in new approaches to fire fighting.

In the description of the scene I read from the Commission report, it was noted that with the exception of substituting engines for horses, the procedures were just about the same as they had been many years before. Once at the fire, men drag the hoses to the burning structure and in most cases, apply the hose streams manually. It would appear that there must be a more effective way to apply hose streams, in view of the tremendous increases in technical knowledge. It might be, for example, some type of automated equipment could be involved to lift the hose without having the fire fighters to do this manually. We all realize that fire fighting is an occupation with the inherent hazard, and we know fire fighters have to enter burning structures in effect to rescue a fire victim. I am suggesting that these men be given technological assistance in doing their job.

One of the most pressing problems facing the fire service, is the prospect of fires in high rise buildings. By this term is meant, one in which emergency evacuation is not practical, and one in which fires must be fought internally because of height. The usual characteristics of such a building are: (1) it is beyond reach of fire department aerial equipment; (2) it possess a potential for specific stack effect; (3) it requires unreasonable evacuation time.

During recent years, construction of tall buildings has changed to a marked degree. For shortly after World War I, buildings were of structural steel encased in concerete, and the floor was a heavy concrete slab with exterior walls built on the walls itself. Now there are paneled walls hanging from the floor deck leaving open spaces between the wall and deck. The entire structure is full of holes to contain air conditioning ducts, utility cables, so forth. The faced windows prohibit emergency ventilating. This means in the opinion of some experts, fire protection in high rise buildings is almost impossible. With this type of building, often occupied by thousands of people, the problems of providing methods of escape from fire becomes a major one.

The high rise community must be protected within the structure itself. This means that devices have to be available which will identify the fire and its precise location to a central fire safety division. There must also be facilities within the building, thoroughly protected from fire and smoke through which the occupants can go to safety. All of this presupposes that technology will be available to pinpoint the location of the fire and then to transmit the information as to which safety center people should go. Occupants might move several floors vertically or move horizontally within the building.

If the occupants remain in a high rise building during a fire, a system must exist for control of smoke and fumes. No doubt there will have to be use of pressure differentials in combination with structural elements to control smoke movement. This calls for emergency ventilating systems with automatic adjustments for various contingencies. It is the view of many experts, that fire safety centers should be equipped to transmit verbal instruction, zoned emergency communication, two-way communication and alarms. The type of operation requires automated equipment.

The problems of high rise buildings and fire was forcefully brought to public attention in 1967 in New York City with a fire at the Time and Life Building. Fortunately that fire did not occur on a working day and did not affect employees. A few months later, a fire on the 31st floor of the Chemical Bank Building resulted in smoke throughout the building requiring evacuation of all the people. In 1970, the fire at 1 New York Plaza followed by one a few months later at 919 3rd Avenue defined the problem of danger to occupants and the potential for excessive property damage in high rise buildings. The fire at 919 3rd Avenue exemplified the difficulty with evacuating occupants. The stair towers were unusuable because of the smoke and people were unable to open windows to secure fresh air. Occupants of the lower 19 floors were subjected to severe smoke conditions and those who tried to use the central stair tower found the smoke unbearable at about the 8th floor. Employees had to go back up the stairs, but smoke was so dense that windows were finally broken to secure fresh air. Employees trying to use the stairs from the top floor found them untenable at the 33rd floor and had to reverse their travel and go up to the roof.

It is estimated that there are about 3,000 fires a year in high rise buildings in New York City alone. The prevalence of such structures throughout the country, indicates the magnitude of the problem, and the need for technological assistance.

The report of the Commission on Fire Prevention and Control stresses the need for development of fire protection devices for the homes of America. There are two general devices available today. One is a heat detector and the other is a smoke detector. There is opportunity here for research on the most efficient devices in home protection. One of the worst hazards for fire fighters is the inhalation of fumes. With the constantly increased use of petroleum derived plastics and with the introduction of more and more furnishings and interior finishes made from such materials, the gases produced by combustion of this material become ever more lethal. There is no way through observation, to determine what sort of atmosphere a fire fighter is going to enter in a burning structure. There is frequently some leakage around the face piece of respiratory equipment and some of these fumes are inhaled. Even if there is no leakage, in some instances, the toxic materials as such, that the breathing apparatus is not effective against it.

If a device could be produced which could analyze the gases in a burning building with a read-out so that fire fighters would know what they face, many diseases of lungs could be prevented, and many of their lives could be saved. The rescue of fire victims is the most important task facing the fire fighter. In order to do this under present conditions, the fire fighters have to enter the building and attempt to locate victims in smoke filled rooms. Often the smoke is so dense that the only way to determine whether people are in the room is by crawling on the floor and groping into corners, in closets, under beds and so forth. It would appear feasible to have some kind of remotely controlled machine which will be able to determine the presence of human beings in such circumstances, thus making it possible for fire fighters to perform their rescue functions more efficiently and quickly. The ventilation of smoke or its removal, possibly by some electronic means would sharply decrease the number of instances of smoke inhalation.

Fire service experts are deeply concerned about the prospect of fighting fires in air craft. An emergency landing, resulting in fire with several hundred people abroad a plane presents tremendous problems. How to get the surviving passengers out of the plane; how to distinguish quickly and accurately those who have suffered injury from those who are in shock; the proper care of uninjured passengers; and the extinguishment of the fire, taken altogether, present a most difficult situation. There is need for initial and imaginative application of automation technology in all aspects of such a fire scene.

For example, the exterior surface of an air plane is made of exceptionally hard metal. This means that special tools are necessary to penetrate the surface for the extraction of passengers. If the plane is on fire, remotely controlled cutting tools to enable this work to be done without additional hazard to fire fighters might well result in speedier access to the plane interior.

These few suggestions are made only to indicate some of the basic needs of the fire service in order to fight fires under present day conditions. It is essential that fire fighters be provided the best equipment, including that which is the result of technological advance.

It is surely not enough to have substituted an engine for a horse and then to have left everything else substantially the same. It must be stated in fairness, that there have been, here and there, some efforts to use modern technology. The point is, however, that no major effort is being undertaken for the application of technology to fire fighting. It would seem that today's technology would be able to provide innovative devices which would augment the necessary physical exertion of fire fighters. There will always be much hazard connected with the occupation; it will always involve personal effort and great risk to the victims of fire and other disaster. Courage of a high order is required for this kind of work. At the same time there must be a new approach to this whole matter of giving these men the very best of equipment for them to perform most effectively their vital role in our society.

William E. Bradley
Automation Consultant

There are some occupations which seem to require man's versatility and moment-by-moment decision-making ability, yet which are so hazardous or injurious to health that thev require extraordinary safety procedures or in some cases man does not undertake such tasks at all. One prime example is deep sea operations for installation and maintenance of equipment for oil and gas production on the continental shelf or slope. Other examples are deep sea salvage, mining on the ocean floor, inspection and exploration. The estimated cost keep a team of eleven divers on station for well completion in a water depth of 250 feet is $25,000 per day. Such work is not only dangerous, it is extremely expensive and inefficient because of the relatively short working time and the large amount of time necessary for decompression.

It appears that another approach to such tasks is to use a class of man-machine systems in which the man is in one place and the machine which he controls is in another. The system is so designed that the man can operate the machine fully as well as if he were located in it. The advantages of such remotely-manned systems, or "Telefactor Systems" as they have been called, is that the man can be kept in a comfortable, safe environment. The machine is designed to perform well in the working environment to which

it is well adapted, and to remain there indefinitely to complete needed tasks. While performing complex tasks several thousand feet below the sea surface, an operator can take time out for lunch while another takes over the controls and continues the work.

The basic technology necessary for remotely-manned systems of this kind has been developed during the past two decades. Applications to important tasks seem overdue, since such applications are completely feasible and urgently needed. Extensive development work has been done but not widely publicized by the AEC, NASA, the Army, the Air Force, and especially the Navy. My entrance into the field occurred in 1956, when I applied for and later was granted the first U.S. patent on head-controlled closed circuit television, a useful, and sometimes necessary component of remotely-controlled systems.

It is necessary to try a head-controlled TV system to fully appreciate their potential. I will try to describe two such systems and then suggest ways in which prompt action might be encouraged to achieve both increased safety and greater National Productivity.

In one system I was seated in a chair with a steering wheel, brake pedal and accelerator pedal before me. A viewing device was fitted over my eyes, held in place with an elastic strap around the back of my head. My head remained free to move or to turn as I wished, in any direction. As soon as the device was in place, I saw in it a very clear, sharp television picture which had two special qualities: first, when I turned my head, I could see other parts of the remote scene around me exactly as if I were located in it. Second, the central part of the picture was remarkedly sharp, while the outer part was slightly fuzzy although still undistorted and clear. To observe a part of the scene acutely, I could turn my head in that direction to center the area of interest within the clear central portion, about ten degrees in diameter.

The scene was a landscape seen from the front seat of a pick-up truck. I stepped on the gas pedal and the truck started to move forward across a field. I turned the steering wheel and headed down the field near the fence avoiding some trees and bushes that were in my path. I was able to drive the truck easily along a slalom course marked with flags until I became overconfident, drove too fast, and brushed a flag.

This was not a simulation. I had remotely driven a real truck in a field about a quarter of a mile away, its controls and television eye connected to the lab through a radio link and a short cable. The experience had been completely natural, except that I could not sense acceleration or roughness of the ride.

The second system was developed at Argonne National Laboratory where I had the opportunity to operate a master-slave manipulator developed for the AEC. Two telescoping manipulators, called slaves, hung down into the room from the ceiling. At the end of each manipulator was a plier-like pair of tongs. Outside the room, where I stood, hung within easy reach a similar set called masters with hand-grips at their ends. When I held the hand-grips and turned or moved them, the slaves tongs inside closed so that it was easy to pick up an object and to put it on a table, or even to take apart and reassemble a small machine entirely by remote manipulation.

Manipulators and more general machines working according to the same principles can be made in many forms. Great manipulators with hydraulic muscles can lift thousands of pounds and handle heavy pipes or beams as easily as a child handles tinker toys. The remotely locator operator simply moves with his hands a scale model of the large manipulator using forces of a few pounds or less.

Alternatively, miniaturized manipulators can be put to work inside pipes or in confined spaces where a man won't fit. Again, the worker views the scene with high resolution television, and causes the minature machine, using appropriate tools, to drill holes, weld structures, make joints or electrical connections or whatever man-like task is required.

Whenever human work, or even superhuman strength is needed in a dangerous environment remotely-manned machines appear to provide a completely feasible approach.

Now, how's that again about the difficulty of divers working below 400 feet? True, the marine environment is extremely difficult, especially in bad weather, and the tasks to be performed are somewhat novel, often requiring large forces; suspended sediment near the sea bottom can make vision difficult, even with well-lighted television; and salt water is traditionally the enemy of metallic machines. Tentative solutions are known for each one of these, and with funding in an amount which is trivial compared to other expenditures already expected and customary for off-shore oil and gas production, an entirely new kind of deep sea technology can be developed quickly. Two kinds of participation are needed: first, we need the practical experience of the ocean engineering contractor personnel who are at present serving the oil companies and are familiar with the tasks to be performed and their possible variations, as well as the working environment to be expected. Second, we need to collect some of those engineers who have already had successful experience with modern remote control equipment so as to take fullest advantage of knowledge and ideas already accumulated from other tasks.

Obviously, other opportunities exist to apply the products of such a development team. Whenever occupational hazards are severe enough to interfere with economically valuable activities, remotely-manned systems appear to provide an ideal answer.

The stage seems to be set to start a new industry which will have the interesting characteristic of not displacing existing industry, but of allowing economic expansion into activities now too hazardous, expensive or unhealthy to be performed other ways. Both Labor and Management have good reasons to endorse such an industry, and urgency of off-shore petroleum production now provides a timely incentive.

Wayne R. Knowles
Division of Waste Management and Transportation
Atomic Energy Commission

The AEC's Division of Waste Management and Transportation (WMT) is responsible for the treatment, handling, storage and/or disposal of all AEC-generated radioactive waste and for storing and/or disposing of all high-level radioactive waste generated by the nuclear power industry in their fuel reprocessing plants.

Radioactive waste comes in many forms, sizes and degrees of hazard. Near the low end of the spectrum of waste there is "alpha waste." Alpha waste can be described as an alpha radiation emitting, non-heat producing, transuranic contaminated waste having a specific activity greater than 10 nano curies per gram. On the other end of the spectrum, there is high-level waste. High-level waste can be described as beta, gamma and neutron radiation emitting, high producing, transuranic contaminated waste. Specific activity for high-level waste is not defined but it is represented by approximately 99% of all the fission products and transuranic elements in spent fuel, except uranium and plutonium which are recovered during fuel reprocessing.

In my presentation today I will describe two small WMT projects that are in the planning/conceptual stages which are relevant to the topic of this particular session on occupational safety and health.

The first project deals with "alpha waste." Alpha radiation can be stopped by thin sheets of most materials, including paper. Alpha radiating material becomes hazardous only if it is ingested or inhaled by man. Physically, alpha waste can be placed in two categories, combustibles and non-combustibles. Examples of combustibles are filter paper, protective clothing, gloves, shoe covers, etc., which are contaminated during fuel manufacturing or reprocessing. Examples of non-combustibles are beakers, test tubes, shipping containers, tools, etc., which are also contaminated during fuel processing. Alpha contaminated waste averages about 60% combustibles and 40% non-combustibles. Since the AEC is responsible for storing and/or disposing of millions of cubic feet of its own alpha contaminated waste over the next few decades, and could be responsible for commercial waste as well, it is very interested in consolidating this waste prior to handling, storage or disposal. Incineration will reduce the volume of combustibles by a factor of approximately 50. Crushing will reduce the volume of non-combustibles by a factor of 2 to 10.

ALPHA WASTE SORTING CONCEPT

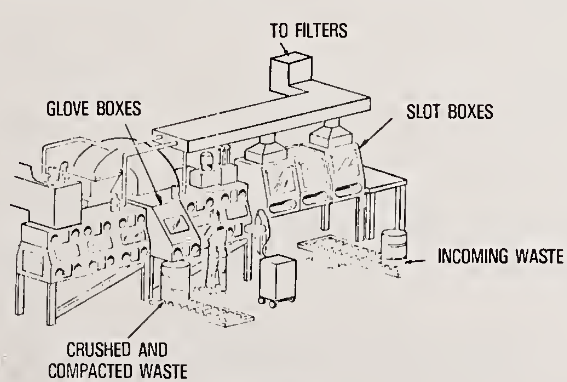


Figure 1

The present concept for sorting alpha waste into combustibles and non-combustibles prior to consolidation is shown in Figure 1. It includes the use of a standard glove box arrangement, where man reaches

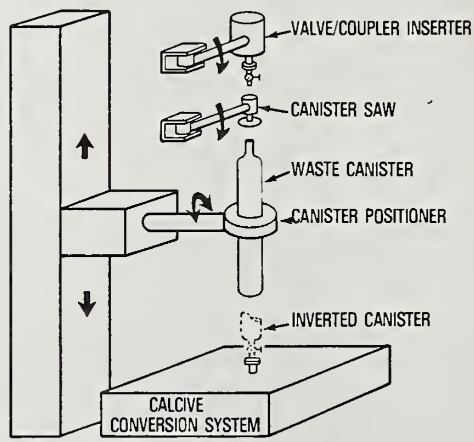
into a box through rubber gloves sealed to the box and manually segregates the alpha waste. Although the glove box arrangement provides adequate biological protection to man, he is still in direct contact with contaminated waste and in a potentially hazardous environment. If a portion or all of the glove box operations were performed by automated equipment controlled by some form of artificial intelligence, operating costs would be reduced and man's occupational safety would be improved.

The second WMT project I have chosen for discussion is the removal of high-level waste from canisters. High-level waste resulting from fuel reprocessing is in liquid form. Fuel reprocessors are required by the AEC to convert the liquid waste to a solid, less mobile form before delivering it to the AEC for storage and/or disposal.

One method for meeting this requirement is to solidify the liquid waste by calcination and seal it in stainless steel canisters that are approximately one foot in diameter by ten feet long. Calcined waste is a grey material ranging in size from powder to pellets the size of #10 bird shot. Another solifidication process converts the calcined waste to a stable, less-leachable vitreous or glass form. In order to convert the calcined waste to a new form, it must first be removed from the canister. That is the objective of the decanning project I am about to describe.

As shown in Figure 2, the canister containing the calcined waste would be clamped in a fixture that is capable of raising, lowering or inverting the canister, a remotely controlled saw would remove the top portion of the neck of the canister, the canister would be repositioned, a specially designed apparatus

Figure 2



CONCEPTUAL DECANNING DEVICE

would insert a coupler and valve into the remaining pre-threaded portion of the neck of the canister, the canister would then be inverted and the coupler attached to the reprocessing system, and finally the valve would be opened to allow the calcined waste to flow out the canister by gravity into the reprocessing system. When the canister becomes empty, the valve would be shut off, the canister decoupled and righted, and removed from the area. All operations would be performed in a highly shielded hot cell and remotely controlled while being viewed through shielded windows or on TV monitors. Again, remotely controlled and somewhat sophisticated automated systems would remove man from a hazardous environment, thus improving his occupational safety and health.

The projects discussed are only two small examples of the many projects envisioned by the U. S. Atomic Energy Commission's Division of Waste Management and Transportation for removing man from hazardous environments and protecting his health and welfare. There are many others, too numerous to mention, where automation technology is being, or will be, applied to reduce costs of operation and to improve man's occupational safety and health.

Ron J. Straw
Director of Development and Research
Communication Workers of America

If I may, I would like to use a layman greeting by saying "Good afternoon brothers and sisters." I am certainly delighted to be here today to talk to you about and give you our views on automation and

occupational welfare. First of all, in case you are not familiar with the organization that I represent, the Communication Workers of America is one of the larger AFL-CIO unions. Joseph A. Burn is the President and has been the President for the past 30 years. We represent about 500,000 telephone workers, an additional 100,000 workers in other occupations ranging from grave diggers to school teachers. Just last week, we entered in bargaining with the National Bell System.

John L. Lewis once said, and I am paraphrasing and I'm not sure of exactly where I read this, that he would be the happiest man in the world if every one of his union men were put out of work because of automation. And I repeat, that he would be the happiest man in the world if every one of his union men were put out of work because of automation. His was a simple choice. The labors his members had to perform were dangerous and dirty and took place deeply in the bowels of the earth. With those criteria, the only question he could ask, or the only question a rational person could ask is, how do you get rid of those jobs? But just as John L. Lewis was forced to confront what might be primitive automation in the coal mines severals years ago, it is that same concern that makes me raise the question as to whether workers or people in general are approaching time when automation and/or technology of industry is not so much of benefit to man kind on the whole as is a threat to their way of life.

It seems to me that this is the reason for this Conference, that we should not celebrate the automation of labor functions as much as we should show our concern for the people involved or affected by that automation. It was that concern for people that pushed John L. Lewis to make the statement that he did.

Thus far, labor has sought to protect jobs from replacement by machines, and has pointed up time and time again about the evils of just being efficient in a technological society. Labor negotiators have sometimes succeeded in making management do some long-term planning and consider the individual affected by automation. In other words, we feel that economic efficiency, while desirable, should not be the dominant norm in any kind of enterprise. We do not accept the maximum output principle, formulated very simply, means that the more we produce of what the hell ever we produce, the better.

This year, CWA will attempt to bargain the right for a new employee to be relieved completely of his or her employment due to technological advancement. We will attempt to insure that the present wage scales are maintained, despite the fact that an employee is reduced a classification or two, and that retraining is available for those who desire retraining. But the important factor is that labor must bargain for the protection of the individual, his income, and his pursuit of happiness. This is done. This is done. Not because we don't like machines. Not because we want to preserve an antiquated system of production, and not because we are greedy for union members and union dues. It is done solely for the reason that our social structure provides no alternatives. There exists no program in this country to guarantee an income to an unemployed worker. And our adequate system of retraining to the best of our knowledge is only adequate. So in the end, what we bargain for is not the preservation of a single individual. Instead we bargain for attrition. That simply formulated means that no one will be thrown out of work. When people retire, die or quit, their jobs will simply not be filled. In this manner we can insure that the benefits due a veteran employee will not be lost. We are preserving a job in a traditional sense, but we are allowing the individual to die slowly, presumably with some dignity. Suddenly the job becomes less facination, less responsibility and more boredom. The worker suddenly joins the syndrome of annihilation. The machine has allowed a greater economic efficiency for the company, but it has reduced the duties of a veteran employee. The employee will not lose his job, he will merely labor under its new constraints until retirement. He has little sense of integrity or self identity and he feels powerless and lonely. This is what I refer to as a semi-automation effect. This also applies to the monitoring that is done by the Bell System on operators. I could almost guarantee you that absenteeism will increase; basic job satisfaction will decrease. And this is exactly what has happened in the auto industry. For example, absenteeism on any given Monday in the auto industry is about 15%. And I need not say anything about job satisfaction. If any of you has worked an assembly line, then you know exactly what I am talking about.

We Americans pride ourselves on our commitment to public education. We have a fairly sophisticated and education population. I think it is time we faced up to the realities surrounding well-educated population which is subject to semi-automation. We have not destroyed his abilities to perform, but we have put upon him mental and emotional strain. Suddenly his skill is gone, his importance lessened, and his contribution to a process which he may have felt an intricate part of is eroded.

The emphasis on automation must be placed on accommodating the needs of people and not so much on efficiency. By this I do not mean that we should forsake technological advancement in order to preserve the employment of a particular group. But when it becomes economically feasible to automate, first considerations should be with people, the employees. Consider the educational levels I mentioned earlier. In this country, we do not educate people from birth in order to perform a particular task in later life. Presumably we depend on a measure of freedom to the individual and the forces of our marketplace to determine what people will do with their lives. Our curriculum are broad in scope and designed to help a person help to develop his or her best ability or interest. Education has come to affect our whole makeup, our beliefs, our awareness and our attitudes. In short, we are dealing with a far more enlightened labor force today than ever before. What I am suggesting is, we are setting ourselves up on a collision course in this country. We are giving our society a higher level awareness through education while simultaneously we are rapidly annihilating people in employement through automation. We

need to ask ourselves two very important questions. Does job retraining apply to those who have been automated only half-way out of their jobs? And two, how will society assess values for personal enrichment in automation worry and in job pressures?

The first question is a simple one. Of course, retraining can work when a particular function is done away with. But in cases where the job only deteriorates through automation, retraining really has no place. The lesser manual functions will remain, only the sense of purpose is removed.

The second question is more complex. I believe that the unit pressures that arise from semi-automation must be dealt with in a humanistic fashion. We cannot really turn the clock back on education, although this administration has vigorously tried to. People will continue to be enlightened, and thus more sensitive to the world around them. To continue the humanization of some forms of work is diametric opposition to the course of our society and our work force. Our alternatives are then more clearly defined. One, we can alter or slow the movement of our national education program in an effort to deter human development. Or two, we offer safety valves to those workers who are uniquely trapped in automation. In this context, I am using safety valve to mean benefit for the sake of further personal betterment. The former of these alternatives, of course is a direct afront to personal freedom, while the later could provide the further education and enrichment to the individual.

For example, the four-day work week could eventually enter the scene as a benefit to those subject to erosion of responsibility and purpose through automation. We can now also consider bargaining for continuing educational grants for those affected. This would allow them to pursue their own interests through traditional educational systems at the expense of the company.

And this brings us to the most vital point, as I understood it. Does Government have a part to play to insure and expanding the personal pursuits of those individuals affected by automation? To this, there is only one answer. If we are to help people whose work and lives are radically changed by the course of technology, then we must realize that this is at a cost. When problems of this nature arise in business and industry, Government has always been quick to respond. Government response has been in the form of tax incentives and Government sponsored loans. The oil industry, for example, has saved billions of dollars from a specially designed tax law. More recently, it has taken Congress a matter of weeks to appropriate money to save the Mississippi chicken farming industry.

But who is to shoulder the cost of preserving the worker. This could be done through private enterprise if labor must bargain for it. But it could also be shouldered by the Government. In this day in age, I would suspect that the Government will either have to pick up the bill or pressure businessmen into including such provisions in contracts. Immediately, many of you may conclude that this is a labor problem, therefore it is labor to bargain for. But if you realized what went into a bargaining of a labor contract, I'm sure that you would see that a proposal to compensate personal pressures which are intangible to say the least, would be several years in the offering. If we could subsidize an industry so that they might continue their efforts, why can we not subsidize people so they might retain their sanity? After all, it is the worker you know that pays 50% of the taxes. The problem of preserving and enriching the lives of automation orphans, if you will, must be tackled. Whether it be through Government or private institutions. To leave this situation unattended would be the same as allowing automation to take place solely for reasons of impersonal economic efficiency.

SESSION III: AUTOMATION FOR THE HANDICAPPED

Chairman: J. Malvern Benjamin, Jr.
President
Bionic Instruments, Inc.

This session on Automation Technology Applied to the Handicapped can best be introduced by two applicable observations. The question was raised in a previous session concerning the advisability of having a centralized planning organization to keep society on the right track in the use of automation technology. This might raise more trouble than it would do good because I think it is more important to have those who venture forth in a technological society come up with a set of attitudes about how technology can be of value to society. The relegation to a central agency of the task to determine good and bad technology would put society in trouble.

There are two areas in which we have to think about this question of technology. The first one is a caveat stating that any planning that we do involving technology should include all of the people that are going to be directly affected. Technology should not be considered as a separate activity but as a part of a total system.

The second point is rather obvious but is frequently neglected. This point stated in its negative form is that technology should never be used for its own sake. Such misuses of technology are frequently ego exercises. A typical example is when are group installs a computer, after which a competing group will install a larger computer, regardless of need.

Another negative area is where the public views any activity or result involving a computer as having an area that provides more credibility than would otherwise be justified.

In our work involving the interfaces between technology and people, there are two examples of the misuse of technology.

One example, occurring a number of years ago involved the use of a color TV system for teaching surgery by displaying actual surgical operations. Although the pictures were superb, the approach was a failure because the students preferred to be in the operating room rather than watching the surgery on a remote monitor. It appears that the <u>total</u> activity in the operation room was as important to the student as the actual surgery. This represents a situation where the technology was not applicable although the technical people involved did not realize it at the time because they had not taken a broad view of the entire activity.

Another example is the system developed by the Model Cities Program in Philadelphia to assist under-privileged and under-educated residents in identifying the appropriate agency to help them with specific problems. In concept, the resident would phone the computer center, and in response to specific questions, the resident would state his problem. The computer would process the information and then advise the resident of the proper agency. In this case the computer system worked as planned, but the activity was a failure because the residents would not use it. They were reluctant to use the phone since it was very impersonal and they did not wish to give the information to a computer. In this case, the potential user was not brought in on the initial planning, and consequently a substantial amount of money was wasted.

In contrast to these examples, the work done by the people who will speak in this session represent activities in which all the factors are considered.

Dr. Kenneth R. Ingham
President
American Systems Incorporated

The system that I wish to describe employs a computer terminal with only two wires coming out of it, one a power cord, and the other a connection to an acoustic coupler, which is attached to a standard telephone. The terminal looks like a standard typewriter keyboard in the middle, with special keys on both sides of the keyboard.

The keyboard is thus connected by telephone to a computer in Boston. The system is called the ARTS system, the acronym for Audio Response Time-Sharing. The ARTS system is a standard time-sharing system

on a minicomputer. However, instead of a visual readout on a CRT or teletype, the readout is performed by a voice response unit and is therefore verbal with a two to three thousand word vocabulary. ARTS can be called from the terminal by a blind person or other handicapped person working at home, school or office.

The output is speech or voice meassages telling the operator what he is doing. The rate of speech can be modified by the operator to suit his requirements. Mistakes can also be easily corrected.

One of the chief services that a blind person would use is called the Ideal Editor service, usually called the "IED". As the keys are typed, the system will speak out their names.

Assuming that a file is not already stored away in a directory which the operator wants to read or study or edit, a new file can be opened by simply typing in the command "fo" for file open. A fresh "page" can be appended to the file. This is equivalent to a secretary going to a bank of filing cabinets to retrieve a folder and putting a sheet of paper in the typewriter.

At this stage, the computer will "listen" to whatever is typed. In considering applications, this system permits a blind student to type in homework, book reports, theses or narratives. Blind secretaries, medical transcribers, or stenographers can use special codes to key in their specialized information. Computer programmers and scientists can type in technical information.

The material that has been typed into the file can be read back to the operator by typing the command "rs" for read sentence. Any error can be easily corrected including deletions and insertions. When the document, report etc. is completed, it can be filed under some name, by giving the command "fc" for file close.

The operator can at this point leave the editor and return to the ARTS monitor. The operator can now ask for the subroutine that will justify the information according to a predetermined format, and then have it printed out in typed copy or in Braille copy.

In effect, the blind person has at his or her disposal a ready means for writing down information in the formats that the sighted world requires.

These tasks that are very simple for the sighted person are very difficult tasks for the handicapped person to do accurately and efficiently. This system, which is built around a minicomputer acting as a time-shared machine, has the capability to do many other tasks. In trying to determine the relevancy of this technology to the handicapped segment of the population we examined the rehabilitation profile of the Massachusetts Commission for the Blind, to see what type of occupations blind people wanted. We found that within the 600 - 800 active cases in the profile, blind people wanted a wide diversity of occupations. These included people who wanted to be models, garage mechanics and students. The major desired occupations appeared to be concentrated in the four areas of education, secretarial, technical professions and business. In all of these occupations, the ARTS system would be of enormous benefit, and in most cases, an absolute necessity.

Looking to the future, books, texts and records can be made available through the ARTS system using reading machines or obtaining inputs from the growing number of other computers in society. Library data bases and literature searches could also be made available. The intent is to find simple, easy to learn techniques that can enhance the employment potential of the blind.

A basic problem in the application of this technology is the delivery of sensory aids. The research and development step along with prototype construction and evaluation are usually adequately funded. However, the third and most difficult step is to find commercial enterprises who would be interested enough, in spite of the limited market, to make these systems and market them to the handicapped.

The basic question relative to all potential applications of automation technology is the problem of marketing a highly specialized technology to a limited group of users, such as handicapped persons. Perhaps the most useful product of this Conference would be the development and implementation of approaches through which capital investment could be made in order to interest commercial firms in manufacturing for limited markets.

Dr. Eugene Kwatny
Krusen Center for Research and Engineering
Temple University School of Medicine

I will speak today, briefly, about several devices or systems which have been developed in our laboratory for aid in the treatment of various sensorimotor disabilities. I will speak in particular about a system which we have developed for use with dyslexic children who have perceptual impairments. This system is based on the theory of providing continuous feedback of information along an intact sensory channel in order to augment processing of information incident on an impaired channel.

Many disabilities of central and peripheral origin result not only from poor motor control or incomplete patterns of muscular innervation, but also from unsatisfactory sensory feedback. That is, information from peripheral sensors going back to the brain or lower neural structures is not sufficient to effect continuous, coordinated control of movement. The control of posture, balance, gait and skilled motor activities is largely dependent upon a spatio-temporal integration of sensory information and the processing of this information to provide adequate motor discharges to accomplish a coordinated act. Many investigations of the impairment of the transformation of normal patterns of sensory input to the central nervous system as a result of a modification of spatial and/or temporal patterns of feedback of performance have taken place. These studies have demonstrated that the eventual outcome is miscalibration of position or force of limb or eye movement or both, leading to perceptuo-motor disability. A basic feature of this research has been to demonstrate the ability of man to recalibrate neural circuits to remove any behavioral disturbances. Recalibration is the most important issue in alleviating sensorimotor disturbances while feedback associated with movement in an important factor in perceptual adaptation to visual, aduitory and somato-sensory disturbances. Extending beyond the studies of the effect of sensory disturbances on motor or perceptual abilities, remediation of certain disabilities may be effected by providing continuous information along an intact sensory channel as a basis for recalibration.

To augment insufficient sensory feedback, information must be provided to the central nervous system via a sensory pathway that is not usually utilized in a particular motor or perceptual activity or one that interferes least with the patient's general functional abilities. The limb load monitor (LLM) is a sensory aid system developed to furnish precise information, both spatially and temporally, of applied vertical load of the lower limb. The degree and rate of change of load are detected by a flexible force transducer placed as an insert within the shoe of the patient. The information is displayed as an auditory signal with the frequency changing as a function of load. The LLM operates in several modes permitting increasing or decreasing frequency with increasing load or an "off response" at a desired load level. The LLM is presently being utilized in patients with amputations, arthrotomies, cerebrovascular accidents and neuropathies. The LLM is used for precise monitoring of partial weight bearing; to provide an orderly progression in control of incremental weight bearing; for sustaining maximal weight bearing; and, to regulate postural and equilibrium responses.

A step-length monitor has been developed for patients who suffer from ambulatory disabilities related to the temporal and spatial patterns of gait. These are manifested in abnormalities such as uneven step length and uneven step timing, resulting in an asymetrical gait pattern. The device consists of an ultrasonic sensor and transmitter, one mounted on each ankle and an auditory display. The ultrasonic components yield a measure of the distance between the feet as discerned by the transmission time of a short burst of ultrasonic energy. The time interval controls the pitch of an auidble signal emitted from a loud speaker. The device is battery powered and worn on the belt of the patient.

Several rather sophisticated laboratory systems have been developed to study physiological and pathological aspects of diseases, which will in turn lead to the development of better treatment programs. A laboratory for the study of postural mechanisms and the effects of sensory disturbances and feedback has been equipped with a platform providing various controllable motions. Complex, total body perturbations may be created by selective control of platform translation, rotation and tilt. During the movements we can measure the patients bodily responses, and in turn provide the patient with sensory information to indicate his performance. This laboratory is fully automated through integration with a computer system providing experimental control, data acquisition and performance feedback.

Locomotion and gait disturbances are studied in a laboratory with a long walkway instrumented with areas for dynamic force measurement and ultrasonic measurement of the position of various anatomical landmarks during locomotion. Various parameters of neuromuscular function may also be dynamically measured. A computer provides experimental control with data collection and processing similar to that in the posture laboratory.

Oculomotor function, or the control of eye movements, is of interest to us because of the role of vision in maintaining posture and in coordinating perceptuo-motor activities. In order for a person to integrate visual information with other activities in which he is involved, he must be provided with good visual information about the environment. This requires that the information provided by each eye is coordinated and a single visual image is provided to the brain for interpretation. An automated laboratory with instrumentation to provide graphic display of both static and dynamic visual images for patient viewing, and instruments to measure the position and dynamics of each eye utilizes a small computer system for experimental control, data acquisition and data processing. Feedback (tactile, auditory or visual) of oculomotor performance is being implemented so that the system may be used as an integrated remediation system.

A diagnostic and remediation system which we have developed for dyslexic and reading retarded children is my primary topic of discussion today. This device is being developed in conjunction with Dr. Helen Schevill and Dr. Paul Bach-y-Rita of the Smith Kettelwell Institute of the Visual Sciences in San Francisco. The device is a spin-off of some work that has been underway for ten years under Dr. Bach-y-Rita's direction; the development of a tactile-visual sensory substitution system for the blind. Dr. Bach-y-Rita's system uses a TV camera to scan the visual environment, and the information is transformed into a matrix of vibratory impulses displayed on the subject's abdomen or back.

We have developed a system for tactile and visual display of symbols or symbol components for instruction of letter and word decoding for dyslexic children. The basic assumption in developing a system which provides tactile augmentation of sensory processing was that children with difficulties in auditory and visual processing could benefit from additional experience and practice in decoding information from a sensory channel other than the visual or auditory. With this system, a child is provided practice in spatial and temporal decoding of tactile input, coupled with a visual display. By correlating what he feels with what he sees, the child learns to integrate his tactile and visual processing. The system will be expanded in the near future to include auditory outputs so that the child with auditory imperception may also learn by tactile augmentation. The system provides display of a symbol in a point by point temporal sequence simultaneously on both a tactile and a visual 7 x 7 point matrix. The display is provided in response to selection of a keyboard element representing that particular symbol. The use of a small, general purpose, digital computer, as the basic system element, enables functional expansion of the system. Additional input or output devices may be included to change the mode of symbol selection or display.

The system is configured with four basic components: a) a solenoid actuated tactile display with 49 factors arranged in a 7 x 7 matrix with a center to center spacing of .5 inches; b) a two part visual display with a larger matrix of 49 light-emitting diodes (LED) arranged as in the tactile display with the same element spacing, and a group of ten smaller (1.0" x 1.0") LED matrices (each 7 x 7 points); c) a minicomputer for system control and generation of the displays; d) a silent keyboard for control of system operation and selection of display symbols.

Any point in the 7 x 7 display area may be addressed and selected at any time. Thus, a symbol may be generated using any sequence of points in any specified order. This flexibility permits the utilization of various types of alphabets for instruction of letter and word decoding. The most elementary symbols are lines of varying lengths and directions to develop temporal and spatial tactile perception. Combinations of these elementary lines can be utilized to develop letter components or "strands". Eventually, the children may be introduced to the complete alphabet (upper and lower case), words, phrases, and even sentences.

On the large visual and the tactile matrices, points are displayed one at a time. The coordinates of the points displayed during the construction of a symbol are also sorted in the memory of the display subsystem. At the end of symbol generation, the complete symbol may be displayed in one of the ten smaller LED displays. These small displays are continuously activated so that the result of a series of symbol outputs is available to the child.

Three basic timing controls are available for modification of the temporal aspect of the display; a) the time between point stimuli; b) the time between line segments used in constructing a symbol; c) the time between display of symbols in a "string" output mode. Each of these timing values may be varied from one-thousandth of a second to several seconds in order to achieve flexibility in sumbol presentation. The string output mode permits the instructor to display a sequence of up to thirty symbols preselected from the keyboard, at a specified intersymbol rate. This is useful in creating words, phrases, and sentences. Modification of the timing sequences as well as several other controls such as specifying the mode of display on the large and small displays, and symbol selection is controlled from the instructor's keyboard.

The system has been in use since September, 1973 in two suburban Philadelphia schools to assess tactile perception and the relationship between certain controlled variables in tactile display and neurological functioning. The initial investigations have been concerned with the determination of absolute differences in tactile perception among and within populations of children at various levels of reading.

Three groups of children are currently under study: a) dyslexic children: specific dyslexics with specific reading developmental problems and organic dyslexics with a mild degree of, or diffuse, organic problems as demonstrated in a neurological exam; b) normal children: age related to the dyslexics and first graders not yet at reading level; c) slow bloomers: second and third graders who are at least one year behind in reading skills. These investigations are providing clarification of the influences of speed of linear movement, length of lines, location of stimuli on the body, timing of successive leters, and complexity of pattern construction on tactile discrimination.

We will obtain data concerned with tactile discrimination and memory in the different groups so that we may relate these parameters to pathology and age; trace certain factors to neurological impairment; and hypothesize about interhemisphere communication related to pathology. These data are necessary before the construction of a rehabilitation program for slow readers is formulated.

The original system has been expanded to permit two students to participate simultaneously in an evaluation or remediation program. A kinesthetic input matrix (similar in size and configuration to the tactile display) is under development. It will permit a student to "draw" a symbol in response to a tactile display, or as input for future display.

Before terminating my presentation, I feel it is necessary to emphasize Dr. Inghan's closing comments concerning the lack of availability of aids developed for the handicapped. The distribution of devices

which I have described today and many others developed in various laboratories across the country has been slow and inadequate because of the lack of funds to move a device from the research laboratory to the consumer and the lack of interest of manufacturing companies because of the small profit margin in producing limited quantity items. Consumer groups become very unhappy when they find that devices such as these could be available, but can not be obtained by the people for whom they were designed.

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Wilfred G. Holsberg
Veterans Administration

The VA Prosthetics and Sensory Aid Service was established in 1945 to provide these services to the veterans returning from World War II. We provide and distribute all of the prosthetic and sensory aid devices for the VA. Prosthetics in this case is broadly defined as any device that supports or replaces a missing or weakened member of the body. This definition has been expanded to include therapeutic and rehabilitative devices as well as some of the more sophisticated implantable items such as the nerve stimulators and cardiac pace maker, etc.

The Prosthetic and Sensory Aid Service has prosthetic representatives located in 175 hospitals and outpatient clinics. These representatives have all suffered a severe disability that has been successfully aided by the wearing of a prosthetic. The Service is dealing with 32,545 low extremity amputees, and 5,952 upper extremity amputees. These constitute only the amputee population among veterans. We are also providing services to 8,459 blind veterans, and 47,543 deaf veterans. Finally, we are providing service to 10,219 paraplegics, and 3,825 quadriplegics.

The VA Prosthetic Center, located in New York City provides much of our bioengineering research services. In this case research is defined as development, evaluation and testing. The VA limits its in-house research activities to the systematic study of only that information about a patient or a system needed to develop a device needed to be used by a patient or in his treatment. The VA bioengineers work in hospitals, in patient's homes and in our own laboratories. From one viewpoint their functions are somewhat similar to that of physicians. Their diagnosis usually consists of a systematic analysis of patient's needs in terms of locomotion, manipulation, or other bodily functions. Their treatment often consists of designing and developing a machine or component which improves the patient's performance.

The VA Prosthetic Center is equipped with a wide range of equipment and facilities for the acquisition of data on human physical performance and bioengineering analysis. Our immediate plans include the acquisition of a minicomputer with a high through-put, and conversational language to facilitate programming for nonrepetitive operations. Peripherals will include storage discs, dynamic x-y-z point optical data digitizers (cathod ray tube) card readers and analog to digital connectors. A unique and substantial portion of scientific data systems includes photometric input. This is an essential element in our advanced scientific effort.

Photometric data can not be efficiently or economically processed by remote computer facilities. The very high volume and high speed through-put of relatively short duration events, for example 24 megabits of information within 12 seconds, can only be handled by on-site computers, because telephone lines can not handle this data input rate.

The on-going work at the Prosthetic Center covers several areas relating to mobility and manipulative disabilities. We have a comprehensive investigation of the interaction of the feet and the walking surface, requiring the use of a glass barograph to record the temporal change of pressure distribution.

A special study has also been underway to use force plates to determine the forces being exerted in three planes as the patient walks across the plates.

Another study involves the use of a static cyclogram where the patient is targeted with light reflecting tape located at strategic points such as the centers of rotation of the ankle and hip. The out-put of the system is a diagram which traces the displacement of various body segments and the angular changes of the joints in two planes.

We are also working on minaturized electronics to control a remote manipulator, with seven degrees of freedom. The manipulator can be mounted on a wheel chair to be controlled by a quadriplegic using possibly a combination of head motions, EMG signals, voice control or breath control.

There is also a great deal more work being done, such as aids to the blind particularly the stereo toner. Further information on these and other projects can be obtained from the VA Prosthetics Center.

Dr. James S. Albus
Institute for Computer Sciences and Technology
National Bureau of Standards

One of the first things that one can say about "Automation for the Handicapped" is that there are a great many varieties of handicapped. Technically anyone who has any kind of medical problem might be considered handicapped. Therefore any application of automation technology to medical problems in general might be reasonably included in this session.

For example, automatic monitoring of intensive care patients, automatic hospital carts for delivering food, linen, and medicines, automatic medical record keeping, automatic medical laboratory analysis, all might be included under the heading "Automation for the Handicapped."

Furthermore, the best way to aid the handicapped would be to keep persons from becoming handicapped in the first place. For example, if automated medical laboratory devices could be made cheap and efficient enough so that medical tests could be given routinely to the general public, it might be possible to shift the entire emphasis of American medicine from the cure to the prevention of disease and disability. In particular, if automatic EKG tests under normal stress could be made routinely for virtually everyone, most cases of heart disease would probably be discovered before heart attacks occurred. Other types of automatic tests might prevent strokes. The availability of routine automatic tests for infection might even totally eradicate some infectious diseases like V.D.

Automation technology might also be applied to such areas as the training of more doctors. For example, computer-aided-teaching devices have proven successful in teaching courses such as anatomy, physiology, chemistry, pathology and many other subjects. In most medical schools the student-teacher ratio is particularly low, in some cases as low as one-to-one. The use of computer-aided-teaching devices could certainly improve this ratio simply by reducing the need for human instructors in presenting the more routine aspects of the information which doctors need to acquire as a part of their education.

One other general area for medical application of automation is the problems of the aged. Older people frequently have problems with mobility. Just getting from the bed to the bathroom and back again is a serious problem for many older people. The inability to get out of bed and move a few yards across the room is frequently cause for institutionalization of otherwise alert and capable people. Furthermore one of the major costs in nursing and convalescent homes is in salaries for nurses' aids who do little more than lift patients in and out of bed.

Surely automation technology should have something to offer in providing lifting and mobility aids for crippled patients. However, so far as I know there are few, if any, such devices which are simple and inexpensive enough for widespread use. The only thing which comes to mind are such trivial devices as crutches and wheel chairs.

These applications of automation technology I mention only in passing, not because I have any particular expertise in these areas, but simply because I feel they should not pass unmentioned in a Conference such as this.

I turn now to the field of manipulator control. There are many persons who have lost the use of their hands or arms, either through paralysis or because of amputation. These people frequently are young, bright and highly motivated. They can often make use of mechanical substitutes for their own limbs. The problem is one of control. How does a patient use a mechanical arm to do what he or she wants?

If only one degree of freedom is involved, the problem is not severe. A simple switch or proportional transducer will suffice. One neat technique, as suggested in the previous paper, is to use myographic signals from an unused muscle to control an actuator in the prosthetic device.

However, if paralysis is complete, the control problem is much more complex. The human arm has a minimum of seven degrees of freedom not counting the numerous degrees of freedom in the hand and fingers. The shoulder has two degrees of freedom, lift forward, and to the side, and the upper arm has a rotational degree of freedom. The elbow is a fourth degree of freedom, the lower arm roll is a fifth, and there are two degrees of freedom in the wrist. The grip is an eighth degree of freedom.

Now controlling a seven or eight degree of freedom manipulator with rate switches is an extremely tedious task and makes any kind of manipulation very difficult to do. The goal of automation technology then is to make it convenient for a person to control a manipulator which is either attached as a prosthetic device, or affixed to some supporting mechanism in the room.

The first step in solving the control problem is to structure the manipulation task so that what is to be accomplished can be expressed in terms of elemental movements which can be carried out in a coorinated fashion. For example, the task of reaching for an object to pick it up is quite simple if it is possible to point the hand in the direction in which you want it to travel, and then give the simple command, "reach." In such a case the coordinated reaching motion can be carried out with a single

command. The manipulator responds by moving along a simple trajectory in space. Unfortunately, this is almost impossible for a person to accomplish with a rate control switch for each joint.

There are two basic approaches to producing elemental coordinated motions in a multidegree-of-freedom manipulator. One is to solve a set of control equations and compute what each individual joint should do in order to produce the desired trajectory. This is perhaps the most straight forward type of solution as long as the problem is confined to simple position or rate control. However, the mathematical approach becomes extremely complex when variables are incorporated indicating the state of touch or force sensors.

A second approach, which we have been investigating here at the Bureau of Standards, is modeled after the mechanisms which are actually used by people and animals in controlling their own limbs. This second approach involves the storage of the joint actuator signals in associative memory so that the proper joint motions can be produced when the memory is addressed with an elemental motion command such as "reach."

The advantage of this associative memory approach to the manipulator control problem is that it enables the controller to incorporate many different kinds of touch and force feedback in the motion computations. These types of feedback are critical in the final stages of motion in delicate tasks such as picking up a glass of water without spilling it or breaking the glass. It is important that the last few centimeters of motion be dependent on what kind of signals are being received from touch and pressure sensors in the gripping device itself.

The type of associative memory-driven control system which we are investigating is adaptive in nature. The memory is loaded by an interactive error correction procedure. This can be accomplished by a large computer system at the factory and then the resulting memory configuration can be loaded on a read-only memory. The control computer used by the handicapped person thus can be an inexpensive micro processor coupled with the factory prepared read-only memory. Studies have shown that memories of less than ten thousand bytes are sufficient for a usable library of elemental motions for a handicapped person.

This type of memory-driven control system is extremely general so that different types of manipulators or elemental motions for operations in different kinds of environments can be accommodated by simply switching read-only memory modules.

Our work in manipulator control systems has drawn heavily from knowledge developed in the fields of neuroanatomy and neurophysiology. In the process, we feel that we have also contributed something to these fields, particularly concerning the questions of how the control computations are logically structured in the brain. Manipulator control, whether it be for a man-made manipulator or for the natural limbs of an animal or a human, requires that higher level goals be partitioned in a hierarchical way into subgoals. At each level in the hierarchy, a higher level goal is used to generate a sequence of lower level subgoals, taking into consideration the relevant feedback information at each level. Assume for example that the goal is to accomplish some complex manipulatory task such as "clear the dinner table." This complex task is made up of a series of simpler tasks such as "fetch," "scrape," "stack," "carry," etc. Each of these tasks can itself be broken down into sequences of elemental movements such as "reach," "grasp," "twist," "lift," etc. These elemental movements can then be broken down into sequences of manipulator end-point translations and rotations. Finally each end-point motion is made up of sequences of joint actuator signals.

At each level a memory driven controller can take a command from a higher level, combine it with the proper feedback signals and generate a sequence of lower level commands.

The possible uses of this concept are numerous. Of course, the handicapped person can use such a control system to accomplish simple everyday tasks in his personal life. This can eliminate the need for outside assistance and make the patient more self sufficient in his private life. However, since this type of control system considerably facilitates the man-machine communication problem, it becomes possible to consider other applications. If the handicapped can control a manipulator, it should be possible for him to control a robot vacuum cleaner, lawn mower, dish washer, or other household device.

These same control principles also apply to man-machine communication problems in business and industry. Control of a machine tool is not essentially different from the control of a manipulator. This raises the possibility of a handicapped person using the same control device to operate a machine in a factory as he uses to operate a manipulator at home. Such an advance would enable many handicapped persons to become full fledged productive members of society.

SESSION IV: RECOVERY OF OCEAN RESOURCES FOR PUBLIC BENEFIT

Co-Chairman: Dr. Athelstan Spilhaus
Special Assistant to the Administrator, NOAA

Co-Chairman: Dr. Milton G. Johnson
Office of the NOAA Corps

Dr. Anthony Mucciardi
Adaptronics, Inc.

A novel approach to modeling from a data base has been developed over the past decade, and applied extensively in many areas in the past five years. The particular application described herein is the forecasting of bacteria in rivers.

An adaptive approach to modeling should consider a number of factors. First of all, in the collection of data one should identify the most informative group of parameters, informative in the sense that they contain the information that provides the maximum payoff with regard to modeling. Secondly, having identified the appropriate subset, what is the structure of a model which can in fact predict something, or infer something, or estimate something of interest. This includes both linear and nonlinear interactions of these parameters, the nonlinear interactions being a by-product giving information about physical correlates between the physical phenomenon and the material in the data.

Thirdly, having identified such a structure, what would its internal parameters be?

The approach followed is based on the idea of initially developing a network of computing elements, each of which competes to do the modeling job all by itself.

The object is to piece together a model from the data, discovering from the data base itself which of the original variables are most informative. Consequently, we can adaptively develop a model which gives us an accurate estimate.

By dividing the data into two groups, called the training set and the testing set, the fraction of the data base in the training set is used to develop the structure of the model and its coefficients. The performance is then checked against the testing set, the remaining fraction of the data.

This modeling technique has many applications and one application of interest to us has been the possibility of predicting the condition of rivers from easily measured environmental variables. We used the Potomac River in our study, and we recorded, over several months, environmental variables such as river flow rate, river staging, the tide level, precipitation and average daily temperatures. These were input variables.

We set up four types of models, a three day forecaster, a six day, a nine day and a twelve day forecaster. In each case the data base was the same.

We found, in our results, the four models predicted within 95% the actual count of the bacteriophage in the river.

In summary, we believe that this modeling approach has the ability to identify from a large data base which of the parameters are most informative, and can also piece these together in an adaptive fashion and to form a function. In the case of a forecasting type function as new data was acquired, the process would bootstrap itself, to, in effect, remodel itself each day as the data was acquired.

Earl J. Beck
Naval Civil Engineering Laboratory
Port Hueneme, California

The ocean in general, and the deep ocean in particular, provides a hostile, opaque environment for the accomplishment of precise tasks. In the water column, visibility is restricted but adequate for on-site visual control of necessary functions. In either the surf zone or in bottom operations in the very deep ocean, the safety requirements of divers or submersibles in a construction situation makes remote control

a necessity, since neither can function near large equipment without sight. With zero visibility, sound is the only available method of positioning of vehicles, cutterheads, and other construction tooling.

This discussion will be focused on the advantages, accuracy limitations, and potential of remote control with a maximum of automation for two major devices, the Deep Sea Corer and the Seafloor Constructor. The first is under development and the other completed through preliminary design.

These two machines illustrate the opposite conditions indicating the need for numerical control in operating ocean equipment. The Seafloor Constructor is in effect a milling machine that will cut to a prepared pattern a desired excavation. The Deep Sea Corer is a complicated machine which is proving to be rather difficult to control.

The functional requirements for a Seafloor Constructor dictate that it should be a tracked vehicle having high stability. It would receive power either from internal packaging or from an umbilical cord to a surface ship. The machine control would be through the use of polar coordinates. One of the most important considerations would be the need to design for the extremely high pressures experienced in the deep ocean.

The control of this system uses a conical transducer which communicates with three transponders which are distributed at random around or outside the work site. The complete transducer-transponder system utilizes a small computer to determine the distances between the transducer and the transponder, by measuring the round-trip time for an acoustic signal. Unfortunately, the accuracy of this system is rather poor. Our preliminary experience indicates that an accuracy of any 5 - 6 feet can be expected, based on only a single interrogation. The accuracy can be improved by repeating the interrogation many times, since the accuracy tends to improve as the inverse of the square root of the number of interrogations.

Another way to accurately position the machine is to use a taut wire. By using a number of potentiometers and simple instrumentation, the position of the machine can be determined with relatively high accuracy.

The Deep Sea Corer is a very complex machine designed to work on the ocean bottom. Experience to date indicates that it is a very difficult machine to control manually, and will probably require some form of numerical control or computer control. It is designed to remotely obtain 10 undisturbed from the ocean bottom, which will be far beyond the current state of the art anywhere in the world.

Richard W. Uhrich
Naval Undersea Center

The deep ocean is an extremely hostile environment where it is neither safe nor cost effective to place man on the scene. Instead, remotely controlled vehicles and equipment, as well as automated systems have and will play a great role in exploration and in performing useful work on the ocean floor.

The Naval Undersea Center has been actively working in the remote control technology area for ten years. Its first year was marked by the first successful operation of the cable-controlled underwater vehicle, CURV. Several CURVS have been built during the past decade. The primary missions of these systems has been the recovery of lost ordnance, such as Mk 46 torpedos. However, a CURV was also used to recover the H bomb off the coast of Spain, and a CURV was used to rescue two men in the Pisces manned submersible off the coast of Ireland.

Within the past 3 - 4 years NUC has built specific teleoperator subsystems for use in undersea operations. One of the major developments is a linkage manipulator. Its principle feature which sets it apart from other rate controlled manipulators is the linkage construction of the arm, enabling the manipulator to operate in a spherical coordinate system.

The manipulator is designed to eliminate cross coupling of the motion functions: that is, azimuth, elevation and extention motions are completely independent. Another important feature is the pantograph action that maintains a constant wrist orientation during any motion of the manipulator. Thus, the yaw axis is always vertical, the pitch axis is always horizontal, and furthermore, all three wrist axes, pitch, roll, and yaw, intersect at a single point. Because of these features, the manipulator is so easy to operate that a severely handicapped person can effectively control it.

By connecting a small computer to the manipulator, the manipulator can be pre-programmed to execute 8 different sequential positions, usually within 1/10 of the time needed to do the operations manually.

Another NUC project was the design and construction of a very small remotely controlled submersible called Snoopy. This vehicle is capable of operating down to a depth of 1000 feet. It weighs about 150 lbs and is portable and easy to handle.

The vehicle carries both a TV camera and a movie camera. It is also equipped with a small hook and reel to recover objects from the ocean floor. The vehicle has an automatic hover control so that the operator merely has to concern himself with the horizontal plane control.

Another vehicle built by NUC is the Submersible Cable Actuated Teleoperator, or SCAT. This vehicle is a test bed for an experimental head coupled television system that is mounted on the front of the vehicle. The TV system is a stereo system wherein the two images are displayed to the operator using two cathode ray tubes and optics mounted on a helmet that is worn by the operator.

As the operator moves his head, the TV cameras on the vehicle are slaved to follow his head motions. This system presents the operator with a full stereo illusion of riding on the front of the vehicle.

In order to do useful work in the deep ocean, NUC has been active in advancing manipulator technology. A recently developed system is the Remote Unmanned Work System (RUWS) manipulator. It is a master slave system based on end-point or terminus control, rather than an exo-skeletal control.

The operator only concerns himself with the motions of the hand. Wherever he moves his own hand, the hand of the manipulator follows. He is otherwise unconstrained. This also means that the designer is not constrained to design the manipulator to resemble or function like a human arm. The grip force which is applied by the manipulator hand is proportional to the distance the trigger is pulled. The three position functions are bilateral, so that the operator has a sense of force feedback. The hydraulic porting of the three wrist functions and the hand are completely internal, so there is no danger of entanglement of hydraulic lines. The tubes which are external to the wrist contain the wiring to the potentiometers which sense the position of the wrist functions.

The subsystems described above appear to have many other applications. First of all the linkage manipulator, because of its simplicity and ease of control, could be an easy "tack-on" to any existing undersea vehicle, either manned or unmanned, to add to the submersible's work capability. In an entirely different application, the manipulator could be an aid to the handicapped in performing general work tasks. There are many situations wherein a small electric version of that manipulator, attached to a wheelchair, could be very useful in doing simple things which are just outside a handicapped person's physical capabilities. It is also hoped that this type of manipulator might prove useful in remote planetary exploration where more sophisticated manipulators are not practical.

Snoopy could be used in any situation where depth or other dangers make it impossible for divers to be used - for example in mine counter measures or in general inspection and recovery. Specifically, it has been suggested that the Coast Guard might find it useful in looking for or recovering contraband materials which have been "deep sixed". It has also been proposed that a Snoopy like vehicle might be used to attach a line to a submarine which has been downed in depths beyond divers capability, to aid in the eventual attachment of a submarine rescue chamber.

The manipulator programmer would provide time saving in a variety of tasks which either require repetitive motion or a return to an initial position. The purpose for which it was originally designed was that of tool replacement. In any work system the manipulator may be required to reach a tool in a specific location and then move it to the work and perform some function. Then the tool must be replaced in it's original location to the site, this task may be performed in a fraction of the time which would otherwise be required. The manipulator programmer could also be a useful aid to the handicapped. A specific example is that of helping the patient feed himself. During the operation of eating he must move his fork from the area of the plate to the area of his mouth, and back, repetitively. With the programmer this function could be performed automatically at the touch of a single switch. It would only be necessary then for him to perform the task of placing the food upon the fork.

Gary Guenther
Engineering Development Laboratory, NOAA

Introduction

"Sea Scan" is the name of a project devoted to the development of an Interactive, Dynamic Scanning, Water Quality Data Acquisition and Processing System being undertaken by the Massachusetts Institute of Technology and the Charles Stark Draper Laboratory with sponsorship from the National Oceanic and Atmospheric Administration.

Purpose

The goals of the Sea Scan system are to provide the scientific community with a sophisticated oceanographic data acquisition system while simultaneously providing the environmental protection community with an efficient means of monitoring pollution levels on the continental shelf as well as in lakes and rivers.

Basic Concepts

At the present time, oceanographic and pollution level data are painstakingly collected by fixed buoys or by hand on a point-by-point basis. Shipboard water quality data acquisition techniques can be greatly enhanced with the implementation of "Dynamic Scanning", which means continuous sampling while underway at a reasonable speed of 5 to 7 meters per second (10-15 kts.). This will provide sufficient data to allow accurate modeling of the macrostructure of ocean dynamics and determination of baseline pollution levels; furthermore, it will provide heretofore inaccessible information and microstructures and accurate surveys of pollution dispersion distributions.

With the advent of sophisticated, minicomputer controlled instrumentation, one can envision the automation of ship's guidance and navigation, data acquisition, data processing, data display, and data storage. Given the availability of near real-time, processed data in a visual format, a scientist can then interact with the data so that the data acquisition tactics are continuously tailored to fit the variegates of the data field. This "Interactive" capability, combined with dynamic scanning data acquisition, will allow the tracking and analysis of moving and changing phenomena such as thermoslines, current interfaces, upwelling, and internal wave fields. It will also permit observation of plumes and dispersion patterns of known pollution sources as well as allowing efficient acquisition of environmental baseline data over large areas.

Utilization

The description and prediction of variations in major oceanographic parameters, even in quite limited geographical areas, is presently impractical because no methods exist for the acquisition of data with sufficient density in space and time. Automation of interactive dynamic scanning is the key which will unlock the masses of data necessary to allow the generation of adequate descriptive and predictive models.

The establishment of environmental baselines in regions subject to potential damage from such stresses as ocean dumping, outer continental shelf gas and oil field development, nutrient and pesticide runoff, toxic metallic and organic outflows, and high temperature water outflows is rapidly becoming an area of primary interest and investment. Subsequent to the establishment of baseline data banks, continued monitoring on a periodic basis is necessary to insure the integrity of the environment and the safety of the ecological systems, and to provide additional continuing data inputs to descriptive models of the important features in the area. Present techniques and facilities are far too few, far too slow, and far too expensive, both in terms of money and man power, to be able to adequately fulfill even the requirements of projects currently being initiated, much less the problems soon to be encountered on a world scale. If the Sea Scan concept of interactive, dynamic scanning data acquisition can be implemented in a reasonably compact and inexpensive modular standarized form, it could be invaluable to a broad spectrum of users such as the various federal governmental agencies, states, universities, and private institutes and foundations.

Implemntation

The major hardware consists of a towed, faired cable with dynamic depressor and multiple sensor stations, RAYDIST radio navigation equipment, and the heart of the system, a PDP 11/40 minicomputer with associated disk drive, "Digivue" plasma display panel, tape drive, and electronics. Sensors planned for the first generation prototype are temperature, conductivity (salinity), and pressure (depth), plus the capability of pumping water on board from various depths. Second generation sensors will include such parameters as turbidity, pH, dissolved oxygen, biological oxygen demand, total organic carbon, nutrients, and chlorophyl a. It is hoped that in a parallel sensor development program, third generation sensors can be found to allow measurements of trace metals, pesticides, PCB's and other potentially dangerous constitutents. On board analytic techniques will probably include such things as gas or liquid chromatography, differential pulse anodic stripping, and/or laser induced fluorescence.

The major software modules, which are outlined in the system block diagram in Figure 1, are:

* navigation and ship's guidance,
* data acquisition,
* data processing and display,
* mission initialization, and
* real time executive with multiprogramming and multiple overlay capability.

With a broad spectrum of potential users and requirements in mind, the approach followed in the implementation of the Interactive Dynamic Scanning System concept is one of maximum generality and flexibility. All scientific software is in FORTRAN to allow users to alter or add programs easily. The data acquisition software is highly sophisticated and unique in that inputs are non-dedicated. This means that sensor arrays (consisting of any mixture of different types of available sensors) are defined during a mission under software control. Data collection is asynchronous with sensors having their own stored calibration curves and software controlled sampling times and rates. The guidance and navigation software, by providing desired heading and velocity information to the helmsman, allows the ship to follow any arbitrary, preprogrammed scan track; this scan track may be interrupted at any time to allow

features of interest to be investigated in greater detail as they are discovered. The display programs currently envisioned present the on board scientist with plots of the ship's track, sensor outputs, and contours of constant value as functions of depth or surface position. Users may implement additional programs for whatever type of analysis and display they desire.

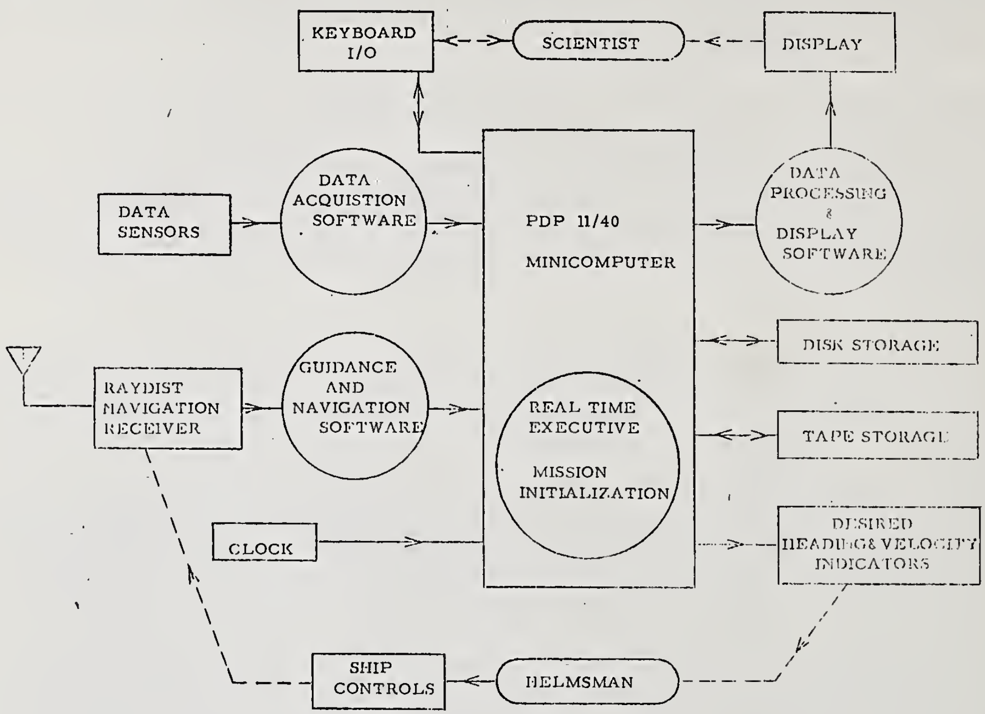

FIGURE 1. SEA SCAN SYSTEM BLOCK DIAGRAM

LCDR Robert H. Cassis, Jr., USCG
NOAA Data Buoy Office
Mississippi Test Facility

Data buoys are automated environmental monitoring and reporting devices. They range from extremely simple mechanisms which measure and report a single parameter, such as atmospheric pressure, to sophisticated systems measuring a wide variety of atmospheric and oceanographic parameters.

Data buoys can provide environmental data to meet a wide variety of needs related to weather analyses and prediction, monitoring of the environment, and scientific research. The meteorological community, principally the National Weather Service, but including the military services and private industry, has a firm and fully validated requirement for meteorological and oceanic data from selected locations which would be used for routine forecasting of weather and sea conditions. At the present time, these prediction systems are hampered by inadequate data from ocean areas. A requirement also exists for buoys which obtain environmental data for such purposes as water quality monitoring; establishment of pollution analysis baseline conditions; the design of structures in the oceans, and for ground truth for other environmental data acquisition and prediction systems such as satellites.

Finally, a great deal of research in oceanography, meteorology, and climatology requires continuous in situ measurements of the marine environment. For many projects of this nature, data buoys are proving to be the most effective means of obtaining the required data. Research requiring marine environmental data is supported by the National Science Foundation, the National Oceanic and Atmospheric Administration, the Department of Defense, the Environmental Protection Agency, other governmental agencies and private industry.

The mission of the NOAA Data Buoy Office (NDBO) is to provide and improve data buoy technology; perform systematic development, test and evaluation for a spectrum of environmental data buoys to meet specific user needs; and provide technical support to government and industrial programs, both national and international.

In order to meet the spectrum of users' needs, the NDBO performs a dual role in serving as a center of environmental data buoy technology and as a center of environmental data buoy applications. As a center for environmental data buoy technology, it is responsible for the systematic test and evaluation, engineering development and transfer of technology associated with environmental data buoys. As a center for environmental data buoy applications, it is responsible for the development of a series of data buoy types necessary to meet the needs of government, science, and industry for marine environmental data.

Figure (1) is a diagram of a typical data buoy. Although it is necessary to tailor each buoy design to the specific intended use, almost all buoys contain modules which correspond to the elements shown in Figure (1). The major components of a buoy are the hull, mooring and payload.

Hulls used by NDBO range from small drifting buoys made of polyvinyl chloride and costing $1,500 to large steel discus shaped hulls which are 40 feet in diameter, weigh 100 tons and cost about $80,000. The NDBO sponsored the development of a computer program which is used to evaluate the performance of a specific hull shape prior to actual construction or modification.

Moorings are often a significant cost element in the data buoy system. The size, cost and reliability of a mooring are functions of the hull shape and size, the depth of water and the expected environment. The NDBO also has sponsored the development of a computer program which is used to evaluate and design moorings for specific situations.

The payload consists of the sensors, data processing and control module, the power system and the communications system. Sensor design is closely correlated to cost and performance objectives, for example oceanographic sensors which contain a hardwired vector computer capable of telemetering data to the buoy. Other sensors consist of just the transducer and analog signal conditioner. The data processing and control modules used have been either software programmable minicomputers or hardwired special purpose processors. The module controls the sequence of events on the buoy, acquires data from the sensors and formats these data for transmission. Quality checks and data compression can also be performed by some processors. Communications can be via high frequency radio links, polar orbiting satellites or earth synchronous satellites. The NDBO is currently using high frequency systems, but is proceeding with the evaluation and eventual conversion to satellite systems. Power systems range from diesel electric generators to common dry cells. Cost, reliability and power density considerations are used to determine the most appropriate power source for any specific application. The development of low power electronics and battery technology now allows buoys to carry more than two years of battery power on board the larger hulls.

Data buoy systems include shore based communications, data dissemination and maintenance facilities. Figure (2) is a diagram of the buoy system concept. The support facilities required to obtain the data and transmit them to the users are complex. Ship services and the high frequency communications station are supplied to NOAA by the U. S. Coast Guard. The maintenance base is located at the NASA Space Technology Laboratory in Bay St. Louis, Miss. and the shore communications station where computers are used to acquire, scale, quality check and disseminate data is located in Miami. Computers are also used at the maintenance base to evaluate data quality and buoy performance as well as to assist in failure analysis and record keeping functions.

The data buoy can be designed to operate effectively in severe environments and is essentially an all-weather device. Since it is unmanned, expensive life support systems are not required and personnel are not subjected to the sometimes tedious and arduous life on board data acquisition vessels. Buoy support work is technically challenging, highly productive and generally desirable. Thus the data buoy as an automated system permits the acquisition of data which is important to the understanding and evaluation of the marine environment's usefulness to man while at the same time providing a meaningful work experience for the system support personnel.

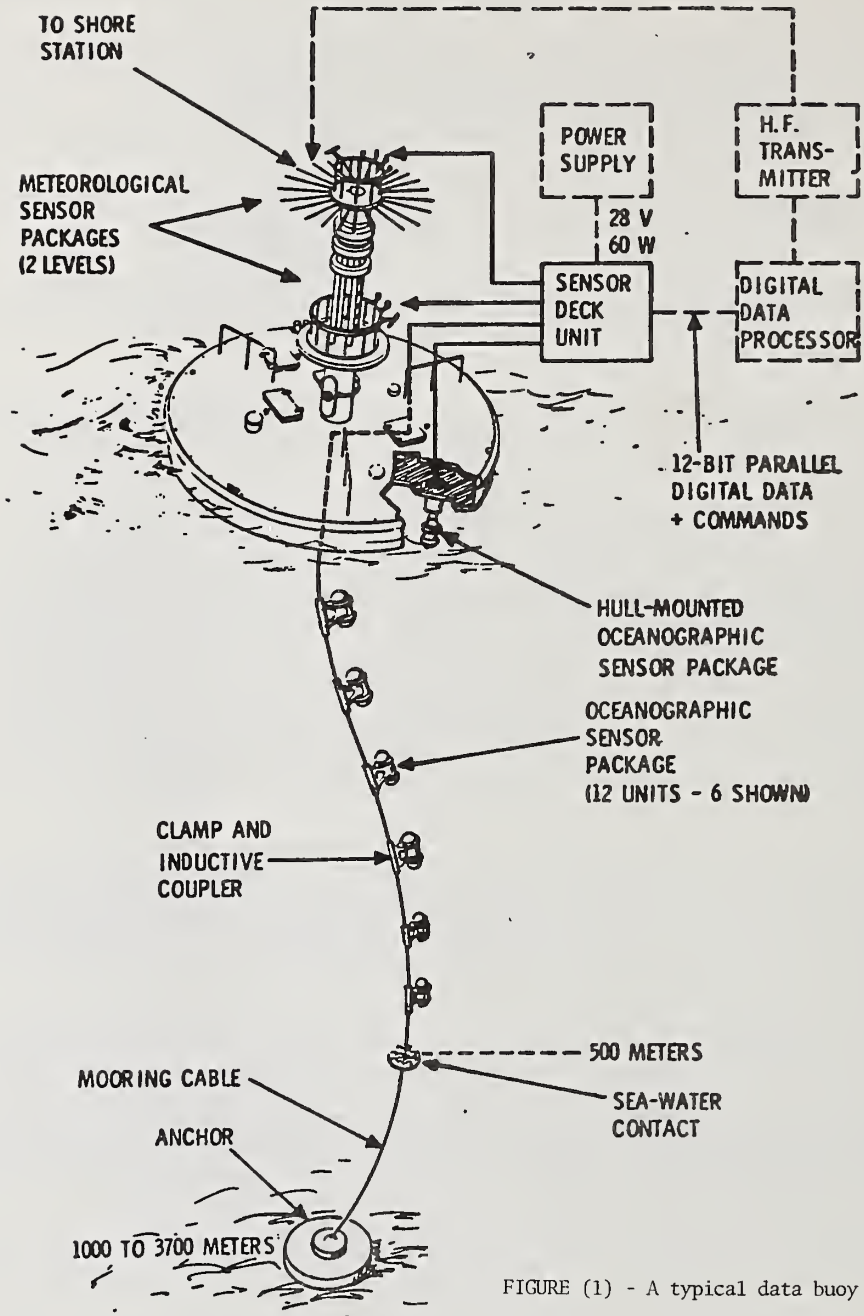

FIGURE (1) - A typical data buoy

GENERAL CONCEPT OF DATA BUOY SYSTEMS

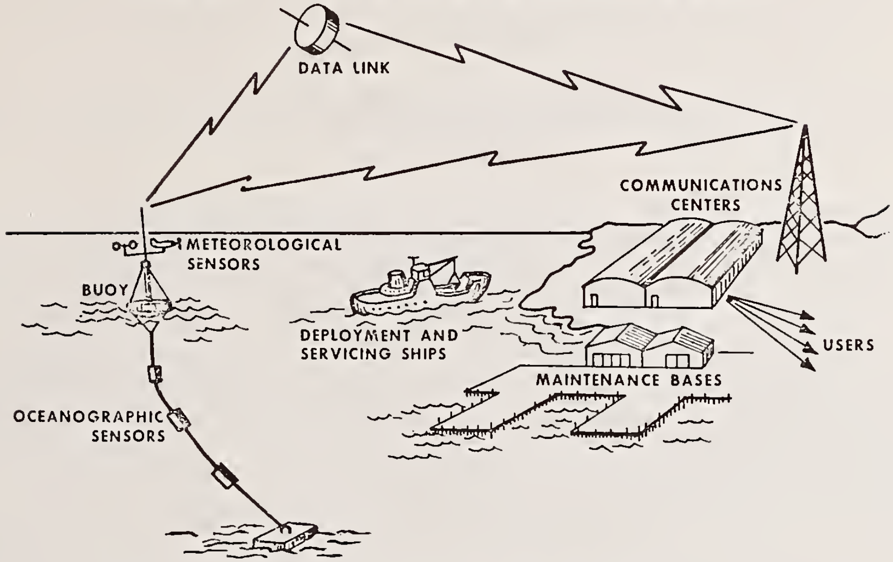

FIGURE (2) - A data buoy system concept

SESSION V: RECOVERY OF UNDERGROUND RESOURCES FOR PUBLIC BENEFIT

Chairman: William B. Schmidt
Chief, Division of Mining Research-Resources
U.S. Bureau of Mines

When one examines graphs which show fossil fuel reserves consumption versus time you can readily determine the reasons for the interest in coal as a national energy resource. According to one set of such statistics, between 1880 and 1980 we will have used the major part of our oil reserves. Similarly these data indicate that by 1980 we will have reached the "half-life" of our gas reserves. In contrast, when we look at coal, these data indicate that we have so far used only a small percentage of our reserves.

Coal has an obvious appeal from the reserve standpoint. However, in examining the pattern of energy consumption, we note that 75% of our national energy is developed by using oil and natural gas, while coal only accounts for about 17%. Obviously the nation needs a shift in its fossil fuel base if the established patterns of life are to be maintained.

Project Independence, the National program to achieve energy self-sufficiency can probably be achieved only by increasing the mining and utilization of coal from the current 17% to 45% or more of our total energy consumption.

If this is to occur, there is a problem in developing practical ways to increase our coal production. Historically, over the past 50 years the U. S. has produced between 400 to 600 million tons of coal. In order to go from 17% to 45%, it will be necessary to triple our coal production to the 1.8 billion ton level.

In considering coal's role and potential problems we should start with a look at recent history. The price of coal has dramatically increased within the past 3 or 4 years, at a rate faster than that for the economy as a whole, and this rise is continuing. This would appear to indicate a possible problem in the coal industry. Investigating further, productivity appears to be a key indicator of the nature of the problem. Over the past 75 years, there has been an impressive growth in coal productivity. However, in 1969, there was a dramatic break in the productivity curve. Between 1969 and 1973, the average productivity in underground coal mining decreased about 28%, or from about 16 tons per man shift down to about 11 tons per man shift.

Studies done by the National Commission on Productivity indicate that improved technology is the most important part of the problem of increasing productivity. Looking at the coal industry, and particularly with respect to underground coal mining which must be the mainstay of our future coal supply, the historical productivity increase has been achieved by increased mechanization. However, the dominant mining system, continuous mining, is twenty-five years old. No new technology has appeared to continue the historical trend. It appears that there is ample justification for pursuing an R & D program to improve mining technology if we are to assure energy to meet our needs. The reason for the discussion here today is to investigate the question of what role (if any) automation has in the solution of coal mining's problems and, in turn, the energy problems of the nation.

There are three basic methods of underground coal mining in use in this country. In the so called conventional system, which accounts for about 35% of underground coal production, individual pieces of equipment are used to undercut the coal, drill the face, load the face with explosives, and to load and transport the broken coal. This system is difficult to automate except on selective basis because equipment is spread out over a wide area, large numbers of people are involved, and equipment is constantly moving from place to place.

A second variation uses a piece of equipment called a continuous miner. The continuous mining method accounts for about 60% of our underground mining production. In the continuous mining method, the functions of undercutting, drilling, blasting, and loading are combined in one machine. It appears that this method can be automated to a higher degree therefore then conventional mining. Automating the continuous miner involves many problems. For example, if man is not involved in the mining operation, how is the interface between the rock and the coal detected? How will the machines be aligned, and how is the shuttle car docked to the machine? The Bureau of Mines' program has begun to develop the technology to automate continuous mining.

The third underground coal mining system is the longwall mining technique. Longwall mining in this country only accounts for about 3% of our coal production. In this system the mine roof is supported

by a row of hydraulic supports. As the coal cutter is moved back and forth across the face of the seam removing the coal, the hydraulic supports are advanced to keep pace with the coal removal, and the mine roof is allowed to collapse behind the hydraulic supports. From the standpoint of automation, this is the more interesting system because the equipment is concentrated in a smaller area, there are few major equipment subsystems at the coal face, and the operation is almost continuous. The Bureau of Mines is also working on the automation of the longwall mining system.

The two speakers which follow present views of what is being and needs to be done from the standpoint of government and the coal mining industry. These presentations emphasize the point that, in addition to new technology, there is a need for new institutional patterns and new approaches to the problems of increasing coal production.

Wilbur C. Helt
Director, Engineering & Statistical Services
National Coal Association

In the crunch of the energy crisis, America's leaders have finally reached a decision they should have made years ago: Coal must become the energy wheelhorse of the nation. The nation needs as much coal as it can get, as quickly as possible. Increased coal production is vital in the months immediately ahead, to meet existing needs. In the mid- and long-term, still greater increases will be required if America is to follow a policy of relying chiefly on domestic energy sources. Production must be doubled in the next ten or eleven years simply to fill the conventional demand for coal. Further, production must be tripled when coal can be converted to synthetic gas and oil on a large scale.

The coal industry accepts this responsibility and is ready and willing to mine more coal in 1974. However to be able to produce more coal requires the cooperation of labor and government, and the removal of present constraints.

We know how much more coal could be produced in 1974, using present machinery and manpower, without overtime work but without considering costs. At the request of the Federal Energy Office and leading Congressional committees, we surveyed the industry in December on how much output could be increased -- assuming that existing obstacles to production were removed. The answer, projected to cover the whole bituminous coal industry, was a surprising 50 to 70 million tons of production in this year alone, an increase of 8.5 to 12 percent over 1973 -- but there were some big "ifs" attached.

We asked the mining companies to estimate their capacity under the following assumptions:

- Labor stability: an end to wildcat strikes and absenteeism.
- Adequate transportation.
- Adequate materials and supplies.
- No inhibiting price restrictions.
- Stringent enforcement of federal and state mine health and safety laws, but without harassment or needless mine closings.
- Relaxation, within health requirements, of air pollution controls to allow the burning of available coal.
- Continued surface mining with adequate reclamation, but no prohibition.
- Changing optimal mining plans where necessary to meet short-term production requirements.

Assuming the cooperation of the miners and government, our survey shows that the industry can boost its average 1973 rate of production by 913,000 tons a week after three months, by 1,355,000 tons a week after six months, and by 2,087,000 tons a week after one year. Thus in the short term of one year, the industry could be producing at an annual rate of 700 million tons.

Long-term expansion, however, entails new mines, new and improved machinery, and additional coal miners. Behind these needs is a requirement for additional capital in large amounts. The need for new capital by 1985 has been estimated at 10 to 15 billion dollars -- a total far beyond the capacity of the coal industry to generate by earnings. The industry must turn increasingly to outside investors. And the investment community, before pouring its money into -- quite literally -- a hole in the ground, wants reasonable assurance that it is coming out again, with a profit attractive enough to lure funds into coal investments instead of in other investments. The coal industry has not had such a rate of return; it must become more profitable if it is to grow or even survive.

The cooperation of labor is always essential if coal production is to be maintained and expanded. Absenteeism and unauthorized work stoppages hurt both management and the miners and their families, but they also damage the nation.

Beyond the immediate goal of better use of the present labor force, however, lies a greatly expanded need for young miners. We must have also an effective means of substituting training and development for years of experience.

Investors also need to know that mines will not be regulated out of business by surface mining or air pollution laws. The need for such assurance is obvious to the coal industry, but it is not always so apparant to Congress.

For the long run, Congress needs to make some trade-offs in the objectives of the Clean Air Act until technology to control sulfur dioxide emissions can be perfected and installed. Without such long-term assurances, the coal industry cannot increase its production of Eastern and Mid-western coal, high in sulfur, to meet the national demand for energy. No short-term variances or postponements to a set date will provide such assurances; they must be contingent on reliable technology coming into service.

At a time of critical need for coal, it is poor policy and worse wisdom to disrupt the production of half our coal output, particularly in view of the need for surface mining to develop the vast coal reserves of the West. Prohibiting surface mining in whole or in part, directly or indirectly, where land can be reclaimed is punitive. The goal of a sensible policy should be to require and assist good reclamation in the wake of responsible mining.

Research and development are critical aids but no cure-all for the coal industry's problems. Government at long last is intent on spending large amounts on coal research. We welcome this but warn that the industry needs more than marvelous new ways of using its product.

To begin with, top priority should be given to research on safer and more efficient production methods, particularly in underground mines. We need continued improvements in basic extractive technology, in moving coal away from the face, in roof control and ventilation and safety.

We do, of course, need more research on coal utilization. Coal gasification and liquefaction processes need to be brought through the pilot and demonstration plant stages to commercial fruition. Additional processes may be developed which should travel the same route. Coal refining processes show promise and should be encouraged also. Other methods, such as fluidized bed combustion, also need more support. For these, and perhaps other processes yet undreamed of, there should be adequate R & D support in the national interest. Some guaranteed purchase or some form of price support may be necessary for their products to launch them successfully.

This may seem a complicated and difficult path to an energy-secure future based on coal. It need not be the proposed legislation that would allow the President to require than existing base-load plants and industrial installations convert to coal, and that all future plants maximize the use of coal as their primary fuel. Existing plants with a remaining life of more than 10 years would be required to develop a three-fuel capability and, insofar as possible, use coal as their primary fuel. Air pollution variances would be granted as necessary where health is not endangered.

A national policy will assure the use of coal in the tasks it is best fitted to perform, and conserve our scarcer fuels for specialized uses. It will assure coal's long-term future markets so our industry can finally plan for and attract the huge amount of capital essential to its necessary expansion.

Congressman Barry M. Goldwater, Jr.
House of Representatives

Automation Technology Applied to Public Resources for Public Benefit is a very timely and important topic. In order to maintain the high standard of living that we enjoy in this country it is obvious that automation will play a critical role. Our future lies in replacing the ways we did things in the past with new ways of doing things, as long as this change is orderly, reasonable, and managed well.

The recent energy shortage emphasized by the long gasoline lines, the threatening voice of city, state, and federal authorities, and by the oil embargo last winter underlines the importance of underground energy resources. It is this aspect of underground resource recovery that I would like to address.

I'm an active member of the Science and Astronautics Committee of the House of Representatives. This activity has caused me to develop a real appreciation of the role which science and engineering must play in solving the problems that we face in the next decade. Last year I assumed a ranking position on the Subcommittee on energy, which is chaired by Congressman Mike McCormack from the State of Washington, one of only two scientists presently sitting in the House of Representatives.

The activities of this Subcommittee during the 93rd Congress have been based on the thorough work and sound recommendations that came out of the hearings of the 92nd Congress. This Subcommittee has been one of the most productive in the House as it pertains to energy and it has produced for the public record an invaluable series of hearings, publications, and related material dealing with almost all aspects of energy technology.

Its members have participated in extensive hearings covering various energy research and development alternatives. My colleagues and I have come to realize the importance of automation in solving energy problems.

The energy shortage which we are experiencing is the simple problem of inadequate supplies to meet increasing demands. To meet these shortages required either a cut back in consumption or an increase in our imports. We can look upon the performance of the American people during the past winter with a great deal of pride. The American people voluntarily conserved fuel consumption and thus lessened the potential catastrophic consequences. This voluntary action pointed up the strength of America, the strength of the individuals that live here and the strength of our system. That system is freedom, and if allowed to operate in an atmosphere of freedom, man will survive, he will overcome, and he will push forward.

Perhaps there are many lessons that can be learned from that recent crisis, one of which is that man must be allowed to be free to pursue the solution of his problems. Too often times government interjects itself into this natural process and botches things.

The long term solution to the energy problem is apparent to us. Energy is basically an economic problem. If there are incentives to achieve desired goals, we will achieve it. The incentive can come in many forms. In business terms, the incentive is usually economic. If there is a profit to be gained, man will achieve his goals. However, when we eliminate these incentives we will not attempt to reach the goal.

Energy is basically a commodity used by man to satisfy his own needs. However, since each individual has his own unique needs, no governmental entity should determine when or how he should use this commodity. The result of this freedom is a condition called the market place, which is a free flow of capital, commodities and services based on demand and supply. As long as we allow that system to work the energy shortage will shortly be overcome.

The current shortage is a technological problem that must be eventually solved by developing new energy technologies. In order to do this, we must develop comprehensive national research and development programs. We must also put together new institutions and incentives to insure that the public and the private sectors of our society and economy work together to solve this problem.

The Government and industry must each do its own share and bring its own particular expertise to the solution and implementation of new energy technology.

What is Congress doing about the energy problem? The Congress is a deliberative body and somewhat unwieldy. Its 535 members all claim to have a solution to the energy problem, but these differences will be eventually ironed out, and it will come to grips with the energy problem. When Congress interjects itself into the market place like it has by holding prices down, it can only discourage incentives to final solutions to the problem.

As far as the Government is concerned, a long range program is required involving both Government and the private sector. The Federal budget for energy R & D has been increasing rapidly. It was about 1/2 billion dollars a couple of years ago, but this year we have just reported out a bill totalling 2.2 billion dollars.

What about Congressional initiatives? What has Congress done on its own to help solve the energy problem? In my opinion, Congress has done absolutely nothing to put one more gallon of gas in my automobile. But, that is not the purpose of Congress. There have been a number of actions in the energy subcommittee that I serve on. We recently reported out a demonstration program for solar heating and cooling of buildings. The subcommittee has also been working on an omnibus geothermal energy research, development, and demonstration bill which we hope to report out this year. One of the major technical challenges in the geothermal program is the development of a high speed low cost drilling method.

Excavation technology is really an amalgam of many different technologies. The drilling equipment is principally a mechanical engineering effort, and new instrumentation to detect the coal-rock interface and to sense the head of the cutting surface is within the purvue of physicists and electrical engineers. The laser specialists help to align equipment, and the whole net progress in the art of rock excavation is the result of the efforts of many disciplines.

The coordination and integration of these different disciplines is of major importance. The Congress has taken positive steps to promote the needed technology since 2.2 billion dollars can do a lot of useful work if put into the right arms.

One of the exciting areas that I have been interested in has been the National Science Foundation's Research Applied to National Needs program, the RANN program. NSF is sponsoring work in the area of excavation technology and associated instrumentation. During the 1970 to 1990 time period, the U.S. will spend about 70 billion dollars for excavation. Consequently, it is prudent for us to invest millions of dollars early in the period to decrease the unit costs for excavation.

In addition to developing new technology, we must also adapt technologies developed in other areas. For example, NASA has developed sophisticated atmospheric detectors which can be used to measure methane-air mixtures. In like fashion we must recognize that the advances we are making in coal

extraction may be used to recover other kinds of underground resources. Our geothermal and shale oil resources may be made more accessible because of R & D work done on coal recovery.

The coordination and integration of many disciplines holds the key to successfully automating the recovery of underground resources. Conferences like this promote the cross fertilization necessary to achieve this purpose. I believe that we can meet the technical challenge of efficiently extracting the underground resources. For my part, I will continue to bring to Congress a greater awareness of the problems and progress, and I am sure that with the joint efforts of the private and public sectors, we will be able to solve these problems.

SESSION VI: IMPACT OF AUTOMATION ON THE PUBLIC

Chairman: Mr. Wil Lepkowski
Science and Technology Editor
Washington News Bureau
McGraw-Hill World News

The meaning, the implications, even the relevancy of conferences come through when they are set against the social and economic issues at play at the time. Automation and the Public Sector conference was held in late May, 1974. Three months before the death of a Presidency, when rampant inflation was the major economic issue, and shortages of energy, food, materials and money were stressful concerns throughout the world. Nuclear technology was beginning to proliferate through the developing countries and political insecurity was beginning to rise once again.

Environmentalists were concerned, too, with the impact of technology on the earth's biosphere. They were worried about spills from enormous supertankers then beginning to move Arab oil around the world. They were concerned over the relaxation of air pollution control laws to allow the burning of high sulfur coal and oil in electrical power plants.

All in all, an insecure, discouraging time.

In the technological world, however, the mood seemed decidedly upbeat. Federal contracts in new or upgraded energy technologies were flowing out to industry as the U.S. aimed toward approaching energy self-sufficiency. Military technology, too, was booming under a record Defense Department research and development budget.

One could see a major paradox in policies. While the world seemed headed into a time of chronic scarcity of materials and capital needed to sustain high technology economics and continued growth, policies seemed stubbornly geared to the assumption of infinite abundance. On the one hand there was the imperative to conserve, on the other the urge to grow. And behind the paradox: outright fear by the people who lend and borrow money of a world-wide economic collapse.

How could automation technology serve to decrease instability and promote benignity? Or how could an automation technology, built on an economic system dependent on abundance, shift its own value system around to serve a world needing fresh approaches to living with scarcity through an ecological economy? The questions were basically ethical and psychological, not mechanical. And, as panelist Michael MacCoby put it, most managers who create new technology unfortunately "never even think of the human consequences of what they are creating. They are neither inclined by character nor educated sufficiently to consider how technology affects emotional health or ethical development."

One of the most important but overlooked reports on applying science and technology the "needs of the times" was issued in 1971 by the Organization for Economic Cooperation and Development. It was called "Information for a Changing Society" and was prepared by a small panel headed by M. Pierre Piganiol of France. Its importance was in its concise statement of the value of knowledge, that is knowledge in both the economic scheme of things and in what might be called the realm of social ecology or the interconnectedness of ideas. As Piganiol said in his introduction:

"The effectiveness of human activities can only be assessed on the basis of a complete chain of events, which passes from scientific knowledge and its creation, through the stages of technical research and through many complex decisions, to the production of goods or services, integrated into an economic and political system. The body of knowledge is in continuous evolution and it is vital, in order to forecast and influence the future, that information should contain at least the seeds of tomorrow's progress and discoveries. What distinguishes modern information from traditional documentation is precisely the introduction of this heuristic element."

Though theoretical and conceptual, his words were a precise guide to making policy in a world where technology -- automation technology -- indeed dominates, and where cybernetic thinking, combined with what the country sages call horse sense, is the only way to manage events in the interdependent world perceived in his speeches by Secretary of State Henry Kissinger.

The major value of the Piganiol report, I believe, was in underscoring the absence of the kind of humanistic information system that could deliver technical knowledge toward policies aimed at improving the quality of life. Such a system obviously doesn't exist. It is a chore in its hardware for

automation technology. But the software -- the ideas, the insights, the wisdom -- are nowhere near compilation, much less implementation. Especially not so when economists are scrambling for new theories to pull the country out of the financial morass threatening it.

How can we achieve the wisdom and the insights needed to make the quantitative and the mechanical more life-sensitive? Obviously, by becoming ourselves more life-sensitive. And how might we do that? We might start by being more self-sensitive. And how might we do that? The question has no single answer, laden as it is with invitations for value judgments. The answer is psychological, economic, and political. When individuals are distraught, they usually seek solutions. If psychological satisfaction fails, they try economic satisfaction. If that fails, they throw the bums out of office, in hopes of tax breaks or government services that may ease their burden.

One of the challenges of automation technology, then, is to give power to people -- power to the common man. Democratic. Jeffersonian. Even journalistic: "Give enough light and the people will find their own way." But that is so easily said. For it isn't the servomechanisms and teleoperations and the information machines that are going to enhance the human prospect, but the information placed in them and the design of policies they are to implement. We are not, therefore, talking about automation technology. We are talking in the philosophical sense about how machines can be made to help people make free choices -- acts of faith, hope, and charity, blended with prudence, justice, fortitude, and temperance.

"A first step in ensuring humane applications of the new technologies," says Ruth Davis, head of NBS's Institute for Computer Sciences and Technology, "is to distinguish between instances when technology is threatening individual rights by abetting dehumanization and instances when technology is being made the scapegoat for failures in human ethics. The proper perspective and potential of these technologies in making headway against today's problems, highlighted by the prominent role of the needs of the individual, needs to be provided to policymakers. It is not presently, and will not be until the ranks of scientific spokesmen are appropriately augmented."

"Appropriate augmentation", of course, is what technology assessment supposedly aims at. But still lacking is the basis of a value system -- a system that perceives human needs, defines human freedom, and acts with that perspective. So we are back to basics in political science, the Constitution, ethics, and psychology. With the economic scene in such flux, the political decisions on how we are to spend the national wealth to attain social ends are also in flux. And when social ends are in flux, values are confused.

"Any progress in knowledge, technology and power that produces a lasting divorce between the experts and the nonexperts must be considered bad," says Andre Gorz of the Dutch Union of Scientific Workers. "Knowledge, like all the rest, is of value only if it can be shared." Information technology can help share it, communication technology can widen debate, automation technology can -- maybe -- speed the consensus."

In the conventional sense, this can only marginally be called a "proceedings" of the panel on automation technology's impact on the public. The enterprise is more a query into technology's role in advancing human potential than a rundown of techniques on making work less tedious and boring. Technologists often equate the two. This is, instead, some commentaries on automation and society, presented during the trouble time of mid-1974.

The fundamental question is to ask how automation can help man become whole and maintain that sense of wholeness. Government's role (four Federal agencies sponsored the conference) isn't necessarily to make man whole, but to create the conditions conducive, in America's case, to the working out of the democratic process.

Therefore, any probe of technology's public impact requires a look at democracy and man's condition in a technological society rather than simply cataloging again and again the technological tools for replacing man's mind and muscle. These techniques are set down in most of the panel papers.

These papers, then, fall a bit out of the usual run of ideas presented at technology meetings. They are "soft", unquantitative, speculative. And the issues are mainly psychological and political. What we have then, we hope, is an agenda for some further work on the functioning of democracy and personal potential in a technological society.

Automation Technology and Its Public Impact

The most important thing to realize in matters of public policy is that there is no such thing as the "public." There are such "things" as persons, however, and persons are really the ultimate receptors of any policies and technologies impacting on the public. The public is a political concept. Persons are real. And so this panel's focus will be on the public as persons.

Automation means many things to persons out there in the public: machines that cough Cokes to thirsty youngsters at turnpike gasoline stations; computer-run systems that navigate supertankers around shoals and icebergs; programmed assembly lines that spill fully assembled cars off the conveyor at the rate of one a minute; and, of course, data banks.

Automation technology speeds processes. It raises productivity. It accelerates the flow of information. It makes everything in the economic stream move faster. And it has a way of nourishing itself toward fuller capacities, toward tighter process control.

But it has created worry. Technologists may like their new technology, but social thinkers and the artists and the humanists don't. Workers don't. Young people especially don't. Automation used for promoting economic growth has a bad name. Maybe a bum rap, but a bad name nonetheless.

The critics say it has produced boredom and frustration on the job, when it hasn't utterly taken jobs away. They say it has forced humans to trot along at a pace dictated more by the speed of the machine than by the naturalness of their own inner rhythms. And they fear the decline in personal freedom as the automation technologies, which operate through control, are applied to the greater and greater control of human beings.

How can automation technology achieve a good name in a period of rising economic and social insecurity? Obviously, by helping make life and work better, and people happier. These goals, of course, involve personal value judgments and as such cannot be approached by programming the questions and feeding them to a computer. If people could program the questions, they'd already have the answers. You can measure parameters that help define life quality. But you can't, I don't think, manipulate a social system to achieve an inspiring life style. It is all too personal.

The purpose of this panel will be to lay out the human challenge to automation technology, not to probe the design of new technologies nor to begin an ambitious expedition into the human condition. We may make an approach toward both, but the point will be the personal focus -- to help persons live their lives free of unneeded control as possible, as unhurried by the pace of the machine as practical with the option to turn it off if he thinks he needs to, and turn on another more appropriate to his needs.

Ben Bova
Editor
Analog Magazine

I've been double-crossed. Will Lepkowski put me last on the agenda which you have all received, and then when I came in this morning, told me I'd be first. I was all prepared to sit back and listen to all the other learned speakers and then tell them what they were doing wrong. But that's going to be impossible. So I'll have to talk a little bit about science fiction's view of this automation conference.

The thing about science fiction is that it teaches you to look at things in the very long term. We do think in terms of millenia and megaparsecs rather than next week's headline, and we tend to take the panoramic view of things, including the panoramic view of human history. And very often, when you want to try to determine where the human race is going in the future, it's instructive to look at where we've been, what our past has to teach us. Now, this entire automation problem is a particular part of the technology that human beings have created for themselves, although an anthropologist might say that technology has created human beings, because technology's roots go far beyond our own physical appearance on this planet. Before there was man -- before there was Homosapiens Sapiens -- there was technology. Very early ancestors of ours a million years ago and more were using pebble tools and animal bones, and basically, technology is a matter of making and using tools. The tools can get very sophisticated, but its's tool making. Instead of adapting physiologically to our environment, instead of growing claws or wings or fur, we have built a technology that in turn forces us to adapt socially, culturally, and psychologically. Now, without technology, long ago -- long before we appeared on this plant -- the human race would have been a deadend. Man without technology is a dead, naked ape. But with technology, we have organized ourselves to a point where we are threatening our own existence in any of several ways. Now the price we have paid for depending so heavily on technology, I think is obvious to everyone in this room. One part of that price is a loss of human individuality. We are mammals; we live in groups; we live in very, very concentrated groups in our Western, technologically dependent society, and the more and more we depend on technology to air condition this room and to provide the fabrics that we wear, carry us from various parts of the compass to this conference, we have to give up some part of our individuality to accomplish these things. So the basic question, I think, for this panel and the conference is quite clear: Does automation technology lead to an increase in human freedom or a

decrease? Essentially, are we serving the machines, or are the machines serving us? I don't think this question has yet been answered, but there are some trends that are easily discernible.

Looking at technology, or even at automation technology in particular, as a force in society, and compare it to the other forces that shape society, just about every major force in any society, is conservative in nature. It seeks to preserve the status quo. It attempts to maintain the situation today exactly as it existed yesterday. You can look at law, politics, religion, tradition -- they are all attempts to keep things the way they were. Now technology by its nature is anticonservative. It's dynamic, it changes things. Every invention, every improvement on a device, every new idea upsets the status quo to some extent. Though it would seem to me in the long run that automation technology is, or can be, an enormous force for human freedom and for liberating the human spirit. It seems to me without technology a million years ago the human race would have died. We would have never survived the ice age. Without the invention of steam machinery; we would still have slavery. Despite all the other social forces moving against slavery, the actual force that destroyed slavery was the steam engine. It became cheaper to use steam than people. I think without the developments of the early twentieth century, without say the internal combustion machine, we would all be on the farm right now, working from dawn to dusk and probably longer to try to produce enough food to feed ourselves. And without the kind of technology we have today, if we suddently stopped our technology -- if that were possible -- I think most of the people on this planet would die.

Now the question of impact of automation technology is, how can we shape it to suit ourselves best? We are going through essentially an industrial revolution. It might be called the second industrial revolution, and like the first industrial revolution, it's a time of great upheaval and no one can see the end of the tunnel. The first industrial revolution was that of steam power, essentially, and it freed many human beings from tasks that required their muscular strength. We began to use machines instead of slaves or serfs.

In the second industrial revolution as we are going through it right now, we are beginning to use automated machinery to free people from the drudgery of repetitive tasks. Just in this morning's New York Times, the lead article in the second section is a story about young workers in industry who find their jobs utterly boring. They have no enthusiasm for it; they just don't care about the work they are doing. Now these are the kinds of jobs that should be done right now by automated machinery. If a task can be done the same way twice, why risk -- why use -- a creative human being? Use a machine. Now eventually, the machines will become creative, too, and that will bring up another problem.

There are people, for example, at MIT who are working toward what they call a self-aware computer, and, in fact, the self-aware computer is a computer that is "intelligent" -- is a staple of many science fiction stories, in a strange way, Carl Jung hit on it also. I don't think he would recognize the computer as the answer to his prayer, but he did say once that psychologists will never be able to understand how the human mind really works, until they have another kind of intelligence against which to compare our own way of thinking.

John McCarthy
Director, Artificial Intelligence Laboratory
Stanford University

I am not going to talk about artificial intelligence. I want to talk about some good things that might be done with home information terminals. But first I would like to express a general view of the role of automation today, and it contrasts with the views of the two previous speakers.

I don't think we are living in a world which is being revolutionized by technology. I think that the direct effect of technology on the life of the average person today -- the rate of change of this -- is less than it was between the ages of 1910, say 1890 and 1920. During that period, much more fundamental changes took place. The development of the automobile, refrigeration, aircraft, radio, the mass introduction of telephones, and so forth. There have been substantial changes recently, but they have been smaller than the changes in that age. However, they are currently perceived to be larger, and there is a certain distortion of perception of the present which leads to a misevaluation of the future.

It seems to me that it is difficult to advocate new technology to people whose perception of what they see in front of them is quite distorted. To quote somebody's comment on science fiction, there was a 1930 model future and there was a 1950 model future, and now we read about the 1970 model future. The science fiction writers tend to copy each other and they seem to have a general kind of a view. I want to make a couple of comments with regard to something that Ben said. The price we paid is a loss of human individuality -- and I regard this as a kind of distortion and it's even contradicted to some extent by what he said, himself, later on, when he compared the life of a person today with the person who works from dawn to dusk getting enough food to keep alive. This is simply a slogan that he's picked up from somewhere. Another contradiction of the same kind, occurs from two quotes that he said -- does automation technology lead to an increase or a decrease in freedom -- this is regarding

automation technology as a kind of impersonal force. And then the other quote was how can we shape it to suit ourselves best -- which is the way I'd like to look at it.

Now I want to talk about home terminals and things that may be based on them. A newspaper or a T.V. station is a substantial commercial undertaking. If you want to get material before the public, then you don't merely have to produce it, you actually have to get somebody with control of a substantial resource to publish it for you. Now let me tell you what is now possible technically, that it is very close to being economically possible.

It is a National information system which can be built of many interconnected sub-information systems in which everything that is published or has been published can be stored in an immediately accessible form. For example, everyone has immediate access to the Library of Congress. Now, all right, this may look like a minor thing. Not very many people use the Library of Congress. But it has some consequences that might not be immediately noticed.

To publish something is to simply put it in the system and declare it to be publically available. So anybody can publish anything. However, people will still have to decide what to read, and they will presumably read it by some trail of things from what they normally read, things mentioned in what they normally read, things they get by word of mouth, or something like that. Nevertheless, there will be an enormous break in the information monopoly. A popular author doesn't need a publisher; he just puts it in the system. And his fans find it and they decide it's worth what he charges for them to read it, and so forth. Whether in such a system there would still be publications, I don't know. I rather imagine that there would. You might like Ben Bova's taste as a science fiction editor, and you would very much like the things that he has put his stamp of approval on by means of coercing the authors to write it better than they otherwise would.

Now, I'd like to mention a few experiments that we have made in that direction. One experiment that we did was to put the Associated Press Wire into our computer, we have a program that reads it continuously and categorizes the stories according to the presence of key words. Let us say you are interested in energy research. You can type into this program energy research, and it will type back to you two stories -- and regrettably the number is usually zero -- for that case -- but sometimes it's as large as two. Or if you say Nixon, then you get 50. If you say Nixon minus Watergate, which means that you like stories that mention Nixon but that don't mention Watergate, then you get 15. In any case, you can have the first lines of these stories appear before you and decide which ones you would like to read. This program has proved quite popular. We are planning to put more news services in, etc., and I think this kind of thing is one direction in which automation can go to eventually break the information monopolies.

Dr. James S. Albus
Project Manager, Office of Developmental Automation and Control Technology
National Bureau of Standards

It seems to me from listening to the sessions here and just what general knowledge I have of the technical field in robot control, that the technology is essentially here to do almost anything that we want. If you don't want to take my word for it, there are a number of people here in the audience who have better credentials in the technical field than I, and just ask them if it isn't true that we really have the technical ability -- we know what is really necessary -- to build robots which would revolutionize the manufacturing industry in this country and the resource development and many other of our very crucial wealth-producing industries.

The questions which are really impeding the introduction of this technology for the benefit of our economic system and, presumably for the benefit of the people within the economic system, are economic, social, and political. There are really two basic questions that I think are at the heart of the hinderance to this particular piece of technology. One is that if the robots can do the work, then how do people get the income? The other question is, if the robots can operate industries by themselves, that represents an enormous concentration of economic power. Who owns that power and who controls it?

What I'm really saying then, is that the two questions of income and ownership in our economic system and in our society are the central questions which are impeding progress in this field. And interestingly enough, although during this conference I've heard questions, the question of income raised by several of the union people, I don't think I've heard the word ownership issued from the podium. And to me that is curious in a society which is capitalist ideology. Presumably, we are hung up on the issue of ownership -- of private ownership -- of property. Yet something as powerful as robots which can completely control industry and can completely do anything that we really wanted to do technically -- we haven't addressed, we haven't even mentioned the word ownership. Who owns these machines and who controls them?

Dr. Daniel V. DeSimone
Deputy Director
Office of Technology Assessment
U.S. Congress

Up until a generation or so ago, technological advance was generally regarded as almost entirely beneficial to mankind. We marveled at the increasing flow of new products and machines that seemed to be making life easier and more pleasurable for millions of people. Technology was a bountiful deity that poured out a seemingly endless stream of wonders:

- computers that did incredible things
- wonder drugs
- synthetic materials for clothing
- vehicles that moved people faster and more comfortably than ever
- devices for home entertainment and instant worldwide communication
- a wondrous array of household applicances and automated equipment
- and in the offing, computers the size of your hand, and the promise of unlimited nuclear power which would further swell the river of technological novelties.

Ours was becoming a steadily more affluent society and, seemingly, a happier one. The view was simplistic, but it was seldom questioned except by a handful of people . . . some with uncommon vision . . . others, just cranks.

Then the pendulum began to swing. Some people who were definitely not cranks warned us to stop and think whether all progress was an undiluted blessing. Among them were a few of the leading philosophers of science and technology. John von Neumann, for example, who had conceived of the modern computer, was one of the first to issue a general warning: He said, "For progress there is no cure. Any attempt to find automatically safe channels for the present explosive variety of progress must lead to frustration. The only safety possible is relative, and it lies in an intelligent exercise of day-to-day judgment."

Joseph Wood Krutch, the humanist, gave us another perspective: "Technology," he said, "made large populations possible . . ." and, he added, "Large populations now make technology indispensable."

We have plenty of people, like Krutch, who do not believe the clock could, or should, be turned back. The benefits of technology cannot be ignored -- e.g., the green revolution, more medical advances, a greater variety of leisure-producing devices. We are more or less successfully feeding and clothing a steadily increasing number of people, and our opportunities for education have expanded enormously. Ben Bova put these benefits of technology in historical context.

At the same time, technology has produced a reaction. There are those who wonder what can be done about the present rate of progress, which they feel is so rapid as to threaten our mental and emotional balance.

In any case, most people agree that we need to control technology and channel it to useful purposes. With this realization was born the technology assessment movement.

What is technology assessment? There are many ponderous technical definitions, but let us begin with a parable. The story is told that in the medieval University of Paris the professors were disputing about the number of teeth in a horse's mouth. They agreed that the number could not be a multiple of three, for that would be an offense to the Trinity; nor could it be a multiple of seven, for God created the world in six days and rested on the seventh. Neither the records of Aristotle nor the arguments of St. Thomas enabled them to solve the problem. Then a shocking thing happened. A student who had been listening to the discussion went out, opened a horse's mouth, and counted the teeth.

Looking into the horse's mouth symbolizes this kind of objective inquiry which is essential to technology assessment. But technology assessment is many other things, too. In a way, it is a social movement, like consumerism. It is a technical art, like forecasting. It is a method of managing change, like systems analysis. It is an integrated way of scrutinizing technology and evaluating its possible effects before opportunities are lost or before irreversible troubles arise.

The role of technology assessment has been both understated and oversold in different instances. Those who have studied the process thoroughly are confident that in some cases a good technology assessment may turn out to be the only way to bring 535 members of Congress together on a common ground in order to discuss the complexities of a difficult technical subject and arrive at a considered decision. But technology assessment is by no means a magical tool for resolving all problems -- not even those that primarily concern engineering and the sciences. A technology assessment is no button that, when pushed, will deliver an unequivocal "right" answer. More likely, it will provide a number of choices, each with its own set of consequences, good and bad.

That brings us to the Office of Technology Assessment.

OTA -- the first thing that happens to a new agency is that it loses its name and becomes an acronym -- opened for business just a few months ago. After almost ten years of widespread public discussion, formal hearings, debate, legislation, and detailed planning and organization, OTA is finally a reality.

OTA is charged with assessing not only the current state and rate of progress of technologies but also their consequences from many viewpoints: physical, biological, economic, social, and political.

OTA thus gives Congress a new window with a fresh outlook on technological issues that are increasingly important in national decision making. A majority of the first technology assessments will deal with some of the most urgent and troublesome problems of our times, including those concerned with preservation of our environment, ecology, wise use of natural resources, human health and safety, assurance of ample food, and long-term social and economic effects on large groups of people, such as the urban poor and small farmers.

Most people see technology assessment as dealing with the negative aspects of technological change -- taming the rampaging bull, so to speak. The other side of the coin -- the neglected opportunities -- is less obvious to non-technical people, but just as amenable to technology assessment. We will be assessing technological opportunities as well as technological failures.

OTA intends to be a truly public agency, which links Congress with concerned people throughout the nation. It can relieve Congress of much uncertainty on highly technical matters. It can point out areas in which the impact of technology on society, and vice versa, are far from obvious. And it can weigh risks, benefits, costs, and alternatives before the pressure of time requires legislative action. But Congress will continue to make the value judgments and ultimate decisions that lead to legislation.

Even at this early stage of its existence, it is clear from all of the requests we have received from Congress that OTA will not suffer from a lack of interest or a dearth of ideas. By this time next year OTA expects to have completed at least one of its major projects and to have others underway.

We will be performing a unique function for the Congress, but I do not want to suggest that our assessments will be magical tools that will vanquish all of the enemies of enlightenment.

It would be irresponsible or naive to assert that technology assessments will always deliver answers, in simple form, that can be translated directly into Congressional action. Yet we will be clearing away clouds, and for every ray of understanding that shines through, we will be grateful. It will have been worth the pitfalls we encountered along the way. We are excited about this enterprise, and I hope we can call upon you to give us a hand as we take on some of the great issues of our time.

Louis K. O'Leary
Assistant Vice President
American Telephone and Telegraph

I'll base my remarks on the experience of my own business, the telephone business, and to talk about the management of technological change automation.

In the minds of some people, we're the ultimate automated industry. As Ben Bova probably remembers, a few years ago there was a movie called The President's Analyst, in which it was revealed that the total society was being taken over by the automated phone company and being run by a whole bunch of Brooks Brothered, android vice presidents. None of whom, by the way, had beards. This movie would have been really a tremendous back-handed compliment to the Bell Labs, but I thought it was a rotten picture.

My business has some claim anyway, for good or ill, to be called highly automated. The heart of that claim is what has been identified, often to the point of boredom, as the world's largest computer -- the nationwide telephone network. An irreverent colleague of mine points out that it's also the world's slowest computer, but he's a purist who ordinarily thinks in nanoseconds. Anyway, we operate with due and deliberate speed an incredible data processing machine which works on demand for many of 110 million input output terminals, any one of which can at any moment select one of the 7 million billion possible connections to reach any other. It has trillions of parts and must work with all of the others with absolutely no down time, even while we are constantly reconfiguring it to meet new and changing demand.

I can allow myself a little gee whiz in talking about it, because it's the baby of our engineering and operating people, and I have no direct responsibility for it -- for which we can both thank God, if you rely on the phone as much as I do. But after that little bit of gee whiz, we get to something that is my concern, both professionally and personally -- the one million people who work at thousands of different jobs so that this big Mother Bell computer works for all of us every time we want it to. That's one million people working on a support system for a computer that serves over 200 million human beings.

Now needless to say, the ubiquitous phone service of today is absolutely dependent on this big computer. We started building it in earnest back in 1920 when we began to convert our manual central offices to

dial operation. Back in 1920, it took 142,000 operators to say "Number, please," and those 142,000 young ladies served some 8,800,000 phones. Today we have 150,000 young ladies and gentlemen as operators serving some 109 million phones. And, of course, you are dialing or key pulsing most of your own calls. If you didn't, and we were still on manual service, you'd be paying probably something like hundreds of dollars every month for local phone service, and we would be employing the total U.S. work force. Actually, the whole damn thing's impossible, so I don't have to calculate the operator ratios to bemuse you.

One final number towards an eventual point. Back in 1920 before these big dial conversions, we had many more operators per thousand phones than we have now. In fact, they were over half of our total work force. We had 229,999 employees back then; now we have far fewer operators per thousand phones, but we have one million employees, as I mentioned earlier. Now, automation may be working quietly and insidiously away to put us all into the full-time leisure market, but at this stage of evolution in my own business, there are very few signs of it. Automation has made the phone much more available and valuable to more and more people, hence more jobs. And to risk a normative judgment, one that would not be widely agreed with in my own business.

In those days, back in 1943, I was a young, liberal type. If someone had identified the establishment for me, I would have been against it. But I didn't know we had one, so I was against the "power elite," if you go back that far. In fact, I was still sorry back in 1953 that Henry Wallace hadn't made President. Yet, I found myself wondering in this job if all this fuss and furor about 23 nice little old ladies was really worth it -- which I submit is kind of a hell of a position for an angry young humanist. After a long meeting with my boss one day, I asked him in effect if we couldn't do the decent thing for these ladies, short of the time we were spending on it, and my boss gave me something of a young Dr. Kildare talk. I don't recall many of his words, but the gist of it was if the Bell system hadn't managed this dial conversion, these 30 years of dial conversion, properly, we would have had a militant and highly virulent labor union by about 1925; we would have had restricting Federal legislation by about 1928; and probably Federal ownership of the phone company by 1932. And then he said something that I really do remember, he said that neither one of us would like the outfit now, either, because it would have become something that would have been hurting people, and neither you nor I would like it. I wish he had something really memorable I could share with you, like "Machines count better than people, Son, but only people really count," or some other such words to live by, but he was kind of an engineer/management type. However, he did know pragmatically that technical change had to be managed with people in mind. And this was a lesson that the system had somehow learned over those decades of dial cutovers, although I really do think that some of it was instinctual, built-in, based on the service values of the outfit going back to its beginning. And that, finally, is my central point. Automation must be managed. Technology must be introduced ready-cut to the human measure. And we also have learned along the way, beware of the romantics who would either wreck or worship the machine -- and we have them in my business on both sides of the fence. And a final thing -- don't ever, ever talk or think about a human employee as a sub-system of a computer design. This is a string of cliches -- I know that -- but I think the experience of my company generally proves that you can make automation work if you live by these cliches and operate from their base. Parenthetically, I want to add very quickly that one of my jobs in my outfit is to come up with better jobs after they are taken apart by technology. And other forms of progress. And we're still learning how to do this well. But we have been just successful enough to give me heart. The beast can be managed, which will leave us with the oldest and biggest problem of all -- who is man and what should he become? And the answer to that, if there is one, will never be punched in any machine. Thank you.

Dr. Michael MacCoby
Director
Harvard Project on Technology, Work, and Character

Whenever there are discusssions of technology and the future, there is such a great danger of getting into a very abstract point of view which does not really take into account either real people or real social and political factors. So that one gets into the situation of talking about all kinds of possibilities. In fact, if one goes to any of the major corporations that deal with advanced technology, one finds probably hundreds, if not thousands, of the most brilliant, creative people who have all kinds of ideas, most of which never become produced or developed. And the question that one should start with is, who creates the new technology and why? And in looking at this over the past decade, I think that one can generalize even though it's always risky to do so, that the major thrust of technological development, of large scale technological development, has obeyed two kinds of principles. One is technology developed by the State, where the underlying principle has been both an increase of security, that's both internal and external security, and also the principle of glory and prestige, which has had a lot to do with the space program. Now those principles both of security and prestige from a psychological point of view, very easily lead to deep irrationalities, because if you are a little bit paranoid, and you have reason to be so, there is never any limit to the amount of security that is secure. And, equally, if you are grandiose, there is no limit to the amount of prestige or glory that you can have. Witness Caligula's desire to have the moon, which has been achieved by one of our recent administrations.

The second principle is the principle of corporate growth and profit. Now the principle of corporate growth and profit is less irrational than that of the Government, because at least it must obey some kinds of principles of market; what sells, and furthermore, in terms of production process, what people are willing to do. Often there is a symbiosis between the Government principle and the principle of the corporations. Sometimes there is a conflict, when the Government's irrationality threatens good business practices, management, and planning. And also interferes with development of markets. But let me go from this to say, to make two points.

The first is, to stress that the motives for developing new technology, from the assembly line to the computer, have not been to further humane development of individuals who work with it. While some technological development may have humane consequences, such as doing away with bad jobs or increasing communication, most managers who create new technology, never even think of the human consequences of what they are creating. And I don't say this theoretically. I say this after a group of my colleagues and I have gone across the country interviewing the leading creators of new technology in corporations. They are neither inclined by character or educated to consider how technology affects emotional health and ethical development. Most never consider the relation of new technology to love of life versus mechanized attitudes. Psychological activeness versus passive consumerism. And greater social equities versus inequity and resentment. Managers do generally believe they are benefitting humanity by (1) creating jobs, (2) making life easier for people, (3) increasing communication, and (4) generally raising the standard of living. But even in cases where they believe they are helping people by creating new technology, social goals do not determine priorities of what is built. The priority is what can be sold the most easily or what is demanded by the State. Some of the more progressive managers do mention that modern technology of production has, in fact, been dehumanizing by instituting systems of rigid hierarchy and fragmentation of work. They do not relate these to their social-psychological effect. Such as, lack of responsible citizenship from those who have no say in the work place and deadening of sensibility due to loss of craftsmanship and ability to determine the pace of work in life according to individual rhythm.

Speaking as a social, psychoanalytic commentator, one must say sadly that the possibility, that given the current system and the current principles that determine technological development, is very great that in the future we will move towards a society of two classes; one of technocrats who are psychologically people who are detached, highly competitive game players, who are all head and little heart, who live in highly protective and privileged enclaves, protected from the second class of people who have not been able to make it -- the losers, full of resentment, who are expected at best to be consumers and who are empty and passive and look for drugs, excitement, and increasingly violence to turn them on.

If we are to avoid this development which is all around us -- there are many signs that we can read it every day in the newspaper of this development. We have to look at this whole question in a totally different way.

Gus Tyler
Assistant President
International Ladies Garment Workers Union

I would like to count the teeth in the horse's mouth. Given a period of time -- the end of World War II up to the present, I think that automation has had a profound impact on the American society. When we were coming out of the second World War, the assumption was that because of automation, in part, we would be moving into a period of massive unemployment. Prior to World War II, there had been technological advances, but the second World War speeded it all up. The Nation was given an almost impossible challenge: how do you remove 12 to 14 million people from the civilian labor force and then meet the demands of both peacetime and wartime production, which is like doubling it all? That was the spark to step up productivity, and we came out of the War with a thing called automation, which was old stuff with a new name on it.

It was assumed that with these smart machines displacing men, you would have growing unemployment. With 12 million people or 14 million returning from the war, you would have still more unemployment, and labor said -- here it comes, back to 1929. But 1929 never came back and from the end of world War II right down to the present, the size of the labor force has grown; the participation rate, that's the percentage rate of people over 14 in labor has grown; unemployment has shrunk; and my guess is that it would be at the present time no more than 3 percent if Nixon had not been elected President of the United States. But even with him, it only goes to 6 percent, so it never happened.

Why did it not happen? For several reasons -- the workers who had been working 44 and 48 hours a week during the war and were getting overtime went on strike and said they wanted the same pay for 40 hours. And they got it. That expanded buying power. Secondly, people had been on a program of forced savings. They now began to spend their money. That was buying power. Thirdly, unions had been negotiating all kinds of pension and welfare funds and now was spending the accumulated money. That was buying power. Government programs -- Social Security, etc. -- were maturing, moving onto the market. That was buying power. New families were being formed, an optimistic moment, and they bought on the installment plan

if they had good credit. That was buying power. The Federal Government instituted a program that was called the GI Bill. It spent billions of dollars on education, on financing new business and buying homes. That was buying power. Then we had foreign programs in which the United States took its money and sent it to the other countries so they could buy from us. That was buying power. The result was that when we were all done, 12 million came back -- they got jobs, they used the automated equipment, they expanded our production, and we had no unemployment, because with increase of supply we had simultaneously increased demand and we were able to move forward as a Nation.

Point number two. The unexpected did happen: the composition of the American labor force did change basically. Automation had its first impact really in the manufacture of commodities. Both in the factory and in the farm. Hence, a smaller percentage of the work force was able to produce the necessary commodities for the entire society. But, automation was not able to distribute those commodities. Therefore, there was a tremendous expansion of people who were employed in advertising, merchandising, communications, packaging, transporting, wholesaling and retailing. That's part of the service economy. Secondly, with the rise in affluence, the tastes of people changed. They didn't abandon their desire for commodities, but they expanded their desire for services. A hair-do, the beauty parlor once a week; home repair, radio repair; car repair; hotels; motels; restaurants; leisure time activities. So we had a tremendous expansion in that service sector of the economy.

Number three. We had grown accustomed to a thing called the Welfare State. And after World War II, the rapid expansion of the Welfare State was no longer at the Federal level, but in State, country and municipal employment and in the educational system, so we had that change in the labor force. Result: By about 1950, we had a fundamental change in the composition of American labor. Prior to that, most had worn blue collars. Now, most wore white collars. Prior, most manufactured commodities. Afterwards, most were engaged in dispensing services. Prior, the great creator of new jobs was the private sector; afterwards, the great creator of new jobs was the non-profit, primarily the public sector. And finally, there's no longer a great expansion at the semi-skilled and un-skilled level. The skilled and professional employee began to grow more rapidly than any other occupational category in the United States.

This was a new kind of a labor force. The ratios changed. Manufacture continued as big as ever. Blue collar as big as ever -- bigger than ever -- but proportionately less and so it changed the composition of the American labor force, and of the American labor movement, so that since the mid-1960's the unions that grew most rapidly were the new unions -- The American Federation of State, County and Municipal Employees; Government employees, educators, people in the service sector. These people are more political than the people who preceded, and that's what changed the character of the American labor movement. The American labor movement now is more political than it ever was in its entire history.

Point number four. The new kind of economy created a demand for women and also made it possible for more women to enter the labor force. At the present time, about 40 percent of the labor force is female. This is largely due to the fact that we have an automated economy. Automated economy produces tremendous expansion in the service sector. Much of the service sector can use part-time employement, so a woman can take care of her home part of the day and work part of the day. Also, it is work scattered in the neighborhoods -- small units -- you work in a nursery school, you work in a doctor's office, a dentist's office, as a school aide, so on and so forth. That is female employment. Also in manufacture, much of the work has been simplified and made lighter, and women go to work in factories. There is a second reason why the woman is able to move so rapidly into the labor force, and soon it will be a female majority in the labor force, and this is due to the fact that the home as an economic unit has been increasingly automated. There is now a washing machine and a dryer; there's a baby diaper service. Foods come frozen or in cans. The result is that the home has been changed. This has a tremendous impact on the new generation that's coming up, about ten million kids under the age of 16, many of them under 6 and under 3, who have both a father and mother, and who grow up parentless because both of them work. This is bound to have an impact upon the child who grows up without a parent on the spot, and it's going to bring tremendous pressure to bear on the society in terms of providing some means of raising these children -- comprehensive child care and the rest. The political implications are endless.

Also the implications on sex roles are endless on the nature of the home and the nature of the child. All of these are involved as the woman becomes increasingly the dominant earner in the United States. May I say in passing, that if women were to withdraw from the labor force at the present time, the number of families with father and mother who live in poverty, now 4 percent, would rise to 13 percent, and that if the women were to withdraw from the labor force at this time, those middle class families that buy homes could not pay the mortgage, and the middle class families that send their kids to colleges could not send their kids to colleges. The women are the big guns in the war against poverty, in the buying of homes in America, and in the education of the middle class of this country.

Final point. Automation has had a tremendous impact on American farming. I don't want to call it automation, but it is. It's the application of scientific techniques -- whatever you may call those things -- on creating the green revolution. We now grow eight stalks where we grew one before. End result: about one million people per annum found themselves as obsolete and excess in rural America. Most of them came off the farms, others were dependent upon their income. It wasn't simply that we were learning to produce more. We were also pursuing an economic policy that tried to curtail production in order

to maintain fairly high farm prices. When you add the two, we got a resultant wave of migration out of rural America into urban America. This happened at a most unfortunate time; urban America was already over-crowded. Much of metropolitan America's central cities were suffering with decaying and badly organized plants. And were living in financial debt. Into this mess came one million people per annum, over about 22 years 22 million people, totally unprepared for urban life, unacculturated, not prepared for jobs. The educational system in the cities was not able to accommodate them. Housing was not there for them, and so there arose in the American cities several million people that could only be described as "urban nomads." Hence, crime, disorders, riot and chaos in urban America -- one of the byproducts of automation in the United States.

This is the period, from 1945 to the present, as I read it. I don't want to go into extrapolations at the present time because he says "Your time is up," but this is just a reading on the teeth of the horse as one person stated.

SESSION VII: AUTOMATION FOR TRANSPORTATION

Chairman: Dr. Robert H. Cannon, Jr.
Assistant Secretary of Transportation

The Department of Transportation is continually active in solving the many problems that are created by a dynamic technology. You may recall that in 1968-1969, the Department of Transportation was confronted with a severe air traffic control problem, a time when it was not unusual for aircraft to orbit Chicago or New York for an hour or more before the air traffic controller would permit the aircraft to land. It was during this period when the air traffic control personnel "slowed down" their functions in a general protest. This protest was largely an anxiety problem because the controllers had such a tremendous responsibility to carry, and they had to carry it all in their heads.

The controllers had to look at raw radar data, and keep in their minds which aircraft was which blip. When the system was overloaded, the only alternative was to instruct the incoming aircraft to orbit until they could safely be controlled.

Since this situation called for urgent remedial action, DoT initiated several studies and research programs. By a fortunate situation involving the implementation of the research, combined with a drop in air traffic due to economic circumstances, DoT is now at the point where the automation that we have added to the air traffic control system has resulted in a smoothly functioning system. If our current plans for continuing R & D in air traffic control are carried out, we will be able to keep on top of any new control problems.

Also, during the 1969-1970 period, an office of R & D policy was created within DoT to examine potential applications of technology to the transportation industry. These investigations included studies to analyze what each technology might contribute, and how effective it might be in terms of potential payoff. The results of some of the studies have highlighted the important actions using advanced technology that can help the transportation industry. As can be expected, these studies also revealed that several proposed technical innovations that seemed desirable as concepts, were actually undesirable. For example, several concepts for improving transportation require large capital investments. On the other hand, it was found that intelligent use of automation could result in a tremendous payoff, because (a) it improved the productivity of the existing infrastructure by an average of 20%, and (b) the cost of deploying automation in existing systems was relatively very small compared to either capital cost or in some cases, operating costs.

Several examples come to mind. For example, we should cite the automated control of traffic lights in cities. This technique has, in experimental set-ups, proven to be effective in increasing traffic flow and reducing trip time, which are the typical measures, but it has also been so attractive that over 30 cities have already installed such systems, and at least thirty more are considering installing such systems.

We believe that our measure of payoff is when a Federal investment stimulates a much larger private investment in the system. It is important to note that the DoT R & D budget is in the order of $400 million per year whereas the total operating-investment of the transportation systems is on the order of $200 billion per year.

Other areas where DoT is investigating the use of automation are (a) tracked systems such as rapid transit, (b) control and management of bus systems, (c) freight car identification and management, and (d) controlling ship movements in harbors. All of these applications promise real payoffs when finally operational.

Dr. Carl R. Peterson
President, Rapidex, Inc.

Experiments using a relatively conventional basic tunnelling method with conventional equipment components indicate that with automation or remote control, an increase of 300% in productivity might be possible. This represents an opportunity where automation could be immediately helpful, rather than at some future date.

The most economical underground method for rock excavation is the conventional drill and blast technique. It is a cyclic process in which blast holes are drilled into the face of the tunnel, the holes are

loaded with explosives, the explosives are "shot," the area is ventilated, and finally equipment is brought in to remove, or "muck," the broken rock, the cycle is then repeated.

In conventional systems, each operation in the cycle must be done in sequence. For instance, loading the holes cannot be done while other holes are being drilled.

Drilling of holes typically takes 1/4 of the total cycle time. It is therefore apparent that if a technique can be devised that would permit continuous drilling and mucking, a fourfold increase could be realized. We are therefore interested in developing a system, using conventional components, that can perform all functions simultaneously. To achieve this goal, research was performed to determine a blasting pattern that will permit continuous operation of all components. In order to achieve a continuous operation, remote control techniques must be used.

The tunnelling concept developed as a result of research can be described as a spiral blasting technique. The face of the tunnel, where excavation takes place, consists of one turn of a receding spiral surface (like a screw conveyor blade), with opposite ends of the turn connected by a plane surface parallel to the tunnel axis. A wedge shaped segment adjacent to this plane surface is blasted free by explosives placed in blast holes drilled along a radial "spoke" outlining the desired wedge. Blasting to an adjacent free surface in this manner provides very high blasting efficiency even if blast holes are fired one at a time to minimize the quantity of flying rock.

The spiral geometry also provides a very important self-shielding action. Major rock fragments are thrown towards the free face, transverse to the tunnel rather than down the tunnel. Thus, machinery standing in the tunnel is not directly in the path of most blast fragments.

Wedge segments are blasted in sequence, each to the same axial depth from the local spiral surface. Thus the spiral is reproduced at the base of each wedge so that the spiral geometry continues turn after turn until the tunnel is completed.

By minimizing the size of individual blasts and directing most fragments transversely, a remote control drill and blast tunnelling machine can remain at the face performing all tasks simultaneously and virtually continuously.

Although the primary direction of the rock blast will be perpendicular to the axis of the tunnel, some rock fragments will be thrown along the axis. A light weight shield designed to protect equipment at the face has proven effective in trials. In practice, the shield extends axially between a radial arm carrying drilling components and the area that is being blasted in order to protect the drilling equipment.

Although preliminary trials excavated a horseshoe tunnel, this technique can also be used for other shapes, including circular and rectangular.

For an 18 foot horse-shoe section the drill holes will probably be either 1 1/2" or 2" in diameter and to a depth of nine feet. Each would be loaded with explosives and initated individually, all under remote control with television monitoring.

Preliminary cost estimates have been prepared to provide a basis for evaluating the spiral tunnelling system. In a situation where standard drill and blast techniques can advance about 38 feet per day, the spiral technique should advance about 150 feet per day, and at about 1/2 the cost. Except for remote control capabilities and remote explosive loading and initiation means, standard tunnelling components are used to achieve this major advance in performance.

Jerry D. Ward
Director, Office of R&D Policy
U.S. Department of Transportation

Dial-a-Ride systems provide a prospect for urban transportation in which buses will be able to transport persons from their doorsteps to any place they want to go. The level of service will vary, depending upon the amount of money consumers are willing to pay to get that service. The first systems will, of course, not be able to provide all of the degrees of flexibility that we can anticipate in about 10 or 15 years, from the combination of flexible route systems interacting cooperatively with fixed route systems.

There is another side to the problem, which is the user's point of view. In addition to the convenience of having a vehicle to provide personalized service, the consumer also wants a reliable information system to supplement the service.

For example, it may be possible for a client to use a touch-tone telephone to (1) inform the computer of his location, (2) call up one of a number of pre-stored destinations, or (3) have voice access to

inform operator of destination not previously stored. These operations would complete the actions required by the client to get his transportation. Through various interaction modes, the control center could provide the client with (1) time of pick-up, and (2) cost of trip.

The above are only examples to demonstrate that the future user information systems could be far better than existing systems. The concept of point-to-point vehicular service along with the point-to-point information will remove the current sense of uncertainty prevalent in using today's public transportation service.

It is anticipated that the cost of using a computer in a Dial-a-Ride system will be a small proportion of the total cost. However, the installation of a good information system such as previously described may require a large capital investment. It is doubtful that such investments can be justified until the ridership of the system has grown to the point where the cost of the information system becomes small on a per mile basis.

This is a typical evolutionary problem of how to implement many features at the same time. In this case, it is anticipated that the quality of the vehicular service will gradually improve, and at some point a dramatic improvement will be made in the information system. These improvements will, in turn, increase the ridership, thus decreasing the cost per passenger mile.

There is no clear indication of how these developments will come about, but it is probable that implementation of these concepts will be some combination of partnership involving the Federal and local governments and private industry.

The third element in a Dial-a-Ride system needed to provide good service will be adequate transfer terminals for the buses. It will be important to have transfers from local buses to express buses and vice versa that are better than currently available.

These three elements of (1) vehicular patterns, (2) terminals for pleasant transfers, and (3) the information systems should be developed as one complete system. This will insure the ability to move point-to-point in major regional complexes.

Daniel Roos
Associate Professor, Department of Civil Engineering
Massachusetts Institute of Technology

One of the more promising applications of automation for urban transportation is a system that has been called Dial-a-Bus, or Dial-a-Ride.

In examining public transportation options in today's environment, the patron has two choices: (a) a taxi cab which will provide direct but high cost service, or (b) conventional bus or air rapid transit which is generally low in cost but with relatively poor service.

The objective of Dial-a-Bus, or Dial-a-Ride, is to bridge the gap between these two concepts and to provide a reasonably high level of service at a relatively low cost.

The Dial-a-Ride system in Batavia, New York is a good example to use in describing the concept. If a person wants to make a trip from an origin to a destination, the person would pick up a phone and dial the central dispatcher. In the down-town area having a high density population, direct line phone would be used instead of dial phones. In either case, the request is received by a dispatcher who is responsible for getting all of the trip requests and then deciding which of a fleet of small vehicles would pick-up the person requesting the service.

The vehicle driver follows the instruction of the dispatcher, but unlike the taxi which picks up and delivers a passenger on a direct route, the Dial-a-Ride vehicle may follow an indirect route in order to pick-up or drop-off other passengers.

The Dial-a-Ride concept appears to have gathered momentum about 1966 when Congress requested that a series of in-depth studies be initiated on how technology could be applied to the problems of urban transportation. The conclusions were released about 1968 and recommended the Dial-a-Bus or Dial-a-Ride concept as the most promising system that could be implemented in the near future. This recommendation was based on the premise that a computer could be used to select the vehicle to pickup designated passenagers.

Several organizations were awarded contracts by DoT to study how this concept could be implemented. These organizations examined economic viability, classification of users, types of vehicles, system design, system interfacing problems, institutional problems, and how to initiate and operate a system. These studies were completed in 1970, and several reports were published.

The research and investigations reached several conclusions. It was clear that a Dial-a-Ride concept was a system that could supplement conventional fixed-route transportation in a variety of ways. In some cases it could provide service either cheaper or better, particularly in the lower to medium density areas where it is very difficult to get adequate coverage with a fixed route system.

Dial-a-Ride can also serve as a feeder to get people in perimeter areas to a train or bus station. In the case of small cities the Dial-a-Ride may be the only viable form of public transportation. As these conclusions indicate, in most cases the Dial-a-Ride concept would be a service to complement the principle public transportation system. Most of the 30 or 40 systems now in use rely on small vehicles such as small vans or mini-buses.

The services offered cover a wide variety, and at the present time, there are no identical services. All of these are small scale systems, and up until the past year, computers were not used on any system. However, some cities are now starting to integrate a computer in their system.

A system being installed in Rochester, New York has started using automation in a number of ways. This system is based on digital communication technology between the bus driver and the dispatching office. When a call is received, the person receiving the call punches the information directly on a card, rather than writing it down. This card is given to the dispatcher, and the instructions are transmitted to the bus driver using digital techniques rather than voice communication. Each vehicle is equipped with a printer to provide instructions to the operator.

The digital communication approach has several advantages. First, it provides a hard copy. In addition, the driver has a faster response time, the chance of interference from other sources is reduced, and as the fleet size increases, the digital system becomes more economical.

The most notable example of computer utilization in Dial-a-Ride systems is the Federally sponsored project in Hadenfield, New Jersey. In this project, a minicomputer is being used to process the information. It appears that a minicomputer can be used to control up to 20 or 30 vehicles.

The experience gained from existing Dial-a-Ride systems is extremely encouraging. These systems have attracted people who have not previously used public transportation. The combination of digital communications and computer data processing is becoming increasingly important because they assure a high quality of service, where reliability is extremely important. It appears that if public transportation is to be a viable alternative to the automobile the issue is not strictly cost, since people are also concerned about the quality of service. The combination of digital communication and computer processing can give the consumer a service approaching the individualized personal service of the private automobile.

Donald L. Cooper
Manager, Houston Office
Transportation Controls, TRW, Inc.

The typical city has already invested a considerable amount of money in automation by installing traffic signals at critical intersections. The early 60's saw a growing interest in connecting all of the signals in a network that would be controlled by a computer. This concept was put into practice by a limited number of cities such as Toronto, San Jose, and Wichita Falls.

In general, however, there was not much done in computerizing traffic control until the Federally funded TOPICS program was initiated in the late sixties. This program provided Federal matching funds for improving traffic operations, which included putting in computerized systems. Since then, several cities have initiated efforts to use automation, or are in the planning stage.

The major components of a computerized traffic control system include sensors in the street, signal lights and controllers, interfacing equipment between controllers and communication lines, the communication link, the signal processing and interfacing equipment, the computer, and display devices.

Recent systems are using minicomputers, because technical developments in minicomputers has provided a capability to handle up to 300-400 intersections. The displays are generally scaled maps with lights that indicate various functions. Some systems use CRT's for displays, and most systems have line printers. The usual sensors are inductive loops or magnetometers. The inductive loop puts out a signal whenever a car is in its field. By measuring the length of the detector pulse and assuming an average car length, the computer can easily estimate the traffic speed. This information is used in appropriate algorithms to control the signal light network.

The objective of traffic signal control is to enable the maximum number of cars to move through a network with the minimum number of stops. In a small network, this objective is not very difficult. However, in a large network with irregular geometry and block sizes, the generation of a good program is very difficult.

Several approaches to control strategy have been developed during the past decade. The control variables are the cycle length, the length of each phase in a cycle, called the "split", and the off-set, or time difference between start of similar phases in each direction. The first generation approach computes all of the signal control patterns off-line, and then stores the computed patterns in the memory. The second generation has no pre-computed patterns. All of the patterns are computed on-line by feeding data coming from the detectors into various types of algorithms. The patterns generated by the computer are then sent out to the controllers. All of the signal lights in a given group will operate on the same cycle pattern if the first or second generation approach is used.

The third generation approach does not have any pre-computed patterns, there are no background cycle lengths, and all patterns are up-dated continually. There are no third generation systems in use, although the algorithms are being developed.

As part of the DoT sponsored Urban Traffic Control System (UTCS) program a second generation system has been developed. This system used two levels of control. In one level of control the signal patterns for the complete network are generated. In the other level, the network pattern is refined on an intersection by intersection basis, accounting for cycle by cycle variations.

Some of the computer operations included prediction of speeds and volumes for the next control period, determination of network groups, network optimization, effect of pattern changes and method for changing patterns. The network optimization is based on an off-line program developed for the Federal Highway Administration, that has been reworked to permit faster analysis using on-line techniques.

The estimated cost for automating a relatively simple network will be about $500,000 per 100 intersections (which is equal to only a few hundred feet of concrete highway).

More complex systems using more sensors and several displays, and programmable controls will cost about $1 million per 100 intersections.

The benefits obtained from these systems are difficult to quantify. Baselines from which to measure benefits are hard to define. Known benefits include energy conservation, decreased pollution, safety, and savings in user time.

Several studies indicate a 20% decrease in travel delay time. By assigning conservative values to these benefits, estimated savings of $1 million/year are not unreasonable.

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16. ABSTRACT *(A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)*

The Conference on Automation Technology Applied to Public Service, held in May 1974, was co-sponsored by the National Bureau of Standards, the General Accounting Office, the National Science Foundation and the Urban Institute. The objectives of the conference were first, to explore the use of automation technology as a means of increasing the efficiency of Government in providing higher quality public services at lower cost; and second, to explore the political, social and economic aspects involved in managing the public service applications of automation. Potential uses of automation technology discussed include automating operations in environments hazardous to safety and health of people, such as fire fighting, and the automation of services that are tedious, boring or demeaning for people to do. The spectrum of potential applications of automation technology in public service ranges from garbage collection to aids to the handicapped and from water treatment process control to the adaptive computerized regulation of traffic in urban areas. Some participants warn that the way in which automation technology is applied must be carefully thought out and supervised in order to minimize disruptive economic and social effects.

17. KEY WORDS *(six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)*

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